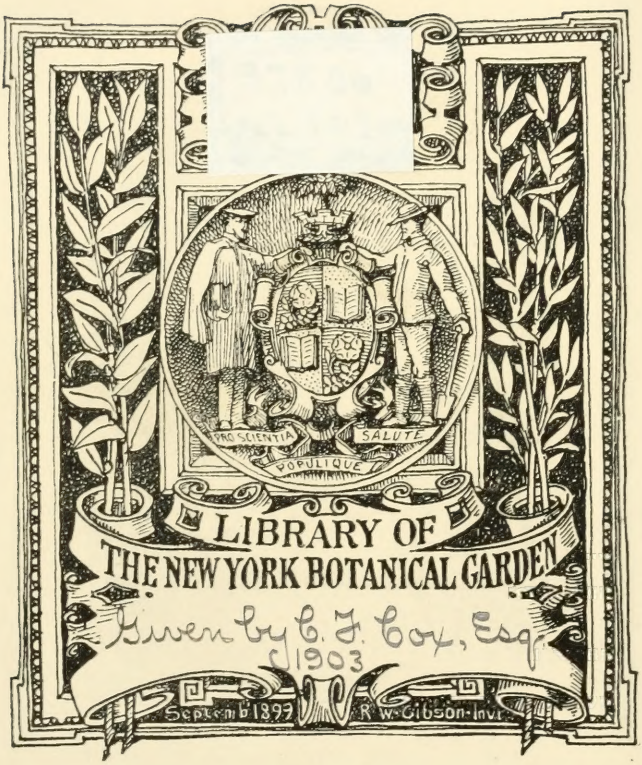
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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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and a Vice-President and Treasurer of the Linnean Society of London;

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FOR THE YEAR

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CHARTER AND BYE-LAWS.

CHARTER.

Victoria, by the Grace of God of the United Kingdom of Great Britain and Ireland, Queen, Defender of the Faith, To ALL TO WHOM THESE PRESENTS SHALL COME GREETING: WHEREAS James Scott Bowerbank, Doctor of Laws, Fellow of the Royal Society; Rev. Joseph Bancroft Reade, Master of Arts, Fellow of the Royal Society; Nathaniel Bagshaw Ward, Fellow of the Royal Society; and others of our loving subjects, did, in the year 1839, establish a Society by the name of "THE MICROSCOPICAL SOCIETY OF LONDON," for the advancement of Microscopical Science:

AND WHEREAS it has been represented to us that the same Society has, since its establishment, sedulously pursued such its proposed object, by the researches of its members, and the collection and discussion of observations, and by the publication of its transactions from time to time, which have contributed to the progress of Microscopical knowledge:

AND WHEREAS distinguished individuals in foreign countries, as well as British subjects, have availed themselves of the facilities offered by the same Society for communicating important discoveries, greatly extending Microscopical knowledge; and the great and general interest now felt in those branches of Science, whereof the Microscope is an important instrument of investigation, has been greatly promoted and fostered by this Society:

AND WHEREAS the same Society has, in aid of its objects, acquired a considerable and important Library of Scientific Works, a large collection of Microscopic objects, and several valuable Microscopes, to which fresh accessions are constantly being made; and the said Society has hitherto been supported by donations and annual and other subscriptions and contributions to its funds, and has therefrom purchased and is possessed of a considerable amount of stock in the public funds:

AND WHEREAS, in order to secure the property of the said Society,

to extend its operations, and to give it a more permanent establishment among the scientific institutions of our kingdom, we have been besought to grant to James Glashier, Fellow of the Royal Society, the present President of the said Society, and to those who now are or shall hereafter become members of the said Society, our Royal Charter of Incorporation for the purposes aforesaid:

Now know ye that We, being desirous of encouraging a design so laudable and salutary, of our especial grace, certain knowledge, and mere motion, have willed, granted, and declared, and do by these presents, for us, our heirs and successors, will, grant and declare that the said James Glaisher, and such other of our loving subjects as now are members of the said Society, or shall from time to time be elected Fellows thereof, according to such regulations or bye-laws as shall be hereafter framed or enacted, and their successors shall for ever hereafter be by virtue of these presents one body politic and corporate, by the name of "The Microscopical Society of London"; * and for the purposes aforesaid, and by the name aforesaid, shall have perpetual succession and a common seal, with full power and authority to alter, vary, break, and renew the same at their discretion, and by the same name to sue and be sued, implead and be impleaded, answer and be answered, unto and in every court of us, our heirs and successors, and be for ever able and capable in the law to purchase, receive, possess, hold and enjoy, to them and their successors, any goods and chattels whatsoever, and also to be able and capable in the law (notwithstanding the Statute of Mortmain) to take, purchase, hold, and enjoy to them and their successors a hall or house, and any such messuages, lands, tenements, or hereditaments whatsoever as may be necessary or expedient for carrying out the purposes of the Society, the yearly value of which, including the site of the said hall or house, shall not exceed in the whole the sum of 1000*l.*, computing the same respectively at the time of the purchase or acquisition thereof, and to act in all the concerns of the said body politic and corporate as effectually, to all intents and purposes, as any other of our liege subjects, or any other body politic or corporate in our said kingdom, not being under any disability, might do in their respective concerns.

And we do hereby grant our special licence and authority unto all and every person and persons, bodies politic and corporate (otherwise competent), to grant, sell, alien and convey in mortmain unto and to the use of the said body politic and corporate and their successors any messuages, lands, tenements, or hereditaments not exceeding such annual value as aforesaid.

And our will and pleasure is, and we further grant and declare,

* On the 1st November, 1866, Mr. Secretary Walpole notified to the President that Her Majesty had been graciously pleased "to command that the Society shall be styled the Royal Microscopical Society."

that there shall be a General Meeting or General Meetings of the Fellows of the said Society to be held from time to time as hereinafter mentioned, and that there shall be a Council to direct and manage the concerns of the said body politic and corporate, and that the General Meetings and the Council shall have the entire direction and management of the same in the manner and subject to the regulations hereinafter mentioned.

And we do hereby also will, grant, and declare that there shall be a President, Vice-Presidents, a Treasurer, and Secretaries of the said body politic and corporate, and that the Council shall consist of the President, Vice-Presidents, Treasurer, Secretaries, and not more than twelve nor less than eight other Fellows of the said Society.

And we do hereby further will and declare that the said James Glaisher shall be the first President of the said body politic and corporate, and the other persons now being the Vice-Presidents, Treasurer, Secretaries, and Members of the Council shall be first Members of the Council, and shall continue such until the election of officers shall be made in pursuance of these presents.

And we do hereby further will and declare that it shall be lawful for the Fellows of the said body politic and corporate hereby established to hold a General Meeting once in the year or oftener, for the purposes hereinafter mentioned; namely, that the President, Vice-Presidents, the Treasurer, the Secretaries, and other Members of the Council, shall be chosen at such General Meeting, and that the General Meetings shall from time to time make and establish such bye-laws, and vary and alter or revoke the same as they shall deem to be useful and necessary for the regulation of the said body politic and corporate, for the admission of Fellows and of Honorary and Foreign Members, and for the fixing the number of the Vice-Presidents and Officers, and for the management of the proceedings, and the estates, goods, and business of the said body politic and corporate, so that such bye-laws be not repugnant to these presents, or to the laws and statutes of this our realm, and shall and may also enter into any resolution and make any regulation respecting the affairs of the said body politic and corporate that may be necessary and proper:

And we do further will and declare that the General Meetings shall take place at such time as may be fixed by the said Council, and that the present regulations of the said Society, so far as they are not inconsistent with these presents, shall continue in force until the same shall be altered by a General Meeting.

And we further will, grant, and declare that the Council shall have the sole management of the income and funds of the said body politic and corporate, and the appointment of librarian, curator, and such other officers, attendants, and servants as the Council shall

think necessary or useful, as also the entire management and superintendence of all the other affairs of the said Society, and shall and may, but not inconsistently with or contrary to the provisions of this our Charter, or any existing bye-law, or the laws and statutes of this our realm, do all such acts and deeds as shall appear to them necessary for carrying into effect the objects and views of the said body politic and corporate.

Provided always, and we do will and declare that the Council shall, from time to time, render to a General Meeting a full account of their proceedings, and that every Fellow of the Society may at all reasonable times, to be fixed by the said Council, see and examine the accounts of the receipts and payments of the said body politic and corporate.

And we further will, grant, and declare that the whole property of the said body politic and corporate shall be vested, and we do hereby vest the same, solely and absolutely in the Fellows thereof, and that they shall have full power and authority to sell, alienate, charge, and otherwise dispose of the same as they shall think proper, but that no sale, mortgage, incumbrance, or other disposition of any messuages, lands, tenements, or hereditaments belonging to the said body politic and corporate shall be made, except with the approbation and concurrence of a General Meeting.

And we lastly declare it to be our Royal will and pleasure that no resolution or bye-law shall, on any account or pretence whatsoever, be made by the said body politic and corporate, in opposition to the general scope, true intent, and meaning of this our Charter, or the Laws or Statutes of our Realm: And that if any such rule or bye-law shall be made, the same shall be absolutely null and void to all intents, effects, constructions and purposes whatsoever.

In witness whereof we have caused these our Letters to be made Patent.

Witness ourself, at our Palace at Westminster, this twenty-eighth day of August in the thirtieth year of our reign.

By Her Majesty's Command.

(Signed) CARDEW.

BYE-LAWS.

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I. Objects.

1. The Objects of the Society are the promotion of Microscopical and Biological Science by the communication, discussion, and publication of Observations and Discoveries relating to (1) Improvements in the Construction and mode of Application of the Microscope, or (2) Biological or other subjects of Microscopical Research.

II. Constitution.

2. The Society shall consist of Ordinary, Honorary, and Ex-officio Fellows, without distinction of sex.

3. The number of Ordinary Fellows shall not be limited. The number of Honorary Fellows shall be limited to fifty, and of Ex-officio Fellows to one hundred.

III. Management.

4. The management of the Society's property and affairs shall be vested in a Council consisting of twenty Members (all being males), viz.:—eight Officers (a President, four Vice-Presidents, a Treasurer, and two Secretaries) and twelve other Ordinary Fellows (hereinafter referred to as "Ordinary Members of Council").

IV. Fellows.

A. *Election.*

(*a*) *Ordinary Fellows.*

5. Every candidate desirous of being elected an Ordinary Fellow must be proposed by three or more Ordinary Fellows who must sign a certificate setting forth his names, place of residence, and description. The Fellow whose name stands first upon the certificate, must have personal knowledge of the candidate.

6. The certificate shall be read by the President, Vice-President, or other Chairman, or one of the Secretaries at the General Meeting next after its receipt, and shall then be suspended in one of the rooms of the Society, and shall be read a second time at the next succeeding General Meeting.

7. The votes on any election of Ordinary Fellows shall be taken by ballot.

8. The ballot shall take place at the General Meeting at which the certificate shall have been read for the second time. No ballot shall be valid unless ten or more votes are recorded; and when at least two-thirds of the votes are in favour of the candidate, he shall be declared duly elected.

9. The Secretaries shall send a notice of election, together with a copy of these Bye-Laws, to every Ordinary Fellow so elected.

10. Every person elected an Ordinary Fellow shall sign the following form of declaration and shall pay the admission fee and first annual subscription or composition within two months from the date of election, or within such further time as the Council may allow. In default of such signature and payment the election of such Fellow shall be void.

I, the undersigned, having been elected a Fellow of the Royal Microscopical Society, *hereby agree that I will be governed by the Charter and Bye-Laws of the Society for the time being; and that*

I will advance the objects of the Society as far as shall be in my power. Provided that when I shall signify in writing to one of the Secretaries that I am desirous of ceasing to be a Fellow thereof, I shall (after payment of all annual subscriptions that may be due from me, and returning any books, or other property belonging to the Society in my possession) be free from this obligation.

Witness my hand the day of 18 .

(*b*) *Honorary Fellows.*

11. Any person eminent in Microscopical or Biological Science shall be eligible for election as an Honorary Fellow.

12. Such person must be proposed by five or more Ordinary Fellows, who must sign a certificate setting forth his names, place of residence, and description, and stating that he is eminent in Microscopical or Biological Science, and that they have a personal knowledge of him or are acquainted with his works.

13. The certificate shall be laid before the Council, and if they approve of the person named therein, shall be read and suspended, and the ballot for such person shall take place in the same manner as is hereinbefore provided for the election of Ordinary Fellows.

14. The Secretaries shall send a notice of election, together with a copy of these Bye-Laws, to every Honorary Fellow so elected.

(*c*) *Ex-Officio Fellows.*

15. The President for the time being of any Society having objects in whole or in part similar to those of this Society, shall be eligible for election as an Ex-officio Fellow.

16. Such person must be proposed by ten or more Ordinary Fellows, who must sign a certificate setting forth his names, place of residence, and description, and the name of the Society of which he is President.

17. The certificate shall be laid before the Council, and if they approve of the person named therein, shall be read and suspended, and the ballot for such person shall take place in the same manner as is hereinbefore provided for the election of Ordinary Fellows.

18. The Secretaries shall send a notice of election, together with a copy of these Bye-Laws, to every Ex-officio Fellow so elected.

19. On any Ex-officio Fellow ceasing to be President of such Society as aforesaid, his successor shall *ipso facto* become an Ex-officio Fellow, unless the Council shall otherwise resolve, in which case such successor must be proposed for election and balloted for in manner provided in Arts. 16 and 17.

B. *Admission Fee, Annual Subscription, and Composition.*

20. Every Ordinary Fellow shall pay an admission fee of two guineas, and a further sum of two guineas as an annual subscription.

21. The annual subscription shall be due on election and thereafter in advance on the 1st of January in each year.

22. Ordinary Fellows elected in March or April in any year shall be exempted from payment of one-sixth of the annual subscription for that year; those elected in May or June, in October, or in November or December, shall be exempted from payment of two-sixths, four-sixths, and five-sixths respectively of such subscription, according to the month in which they are elected.

23. Any Ordinary Fellow who may permanently reside out of the United Kingdom shall be exempted from payment of one-fourth of the annual subscription; and any Ordinary Fellow who may be absent from the United Kingdom during the whole of one year, shall, upon notifying the fact to one of the Secretaries in writing, be similarly exempted during such year.

24. The Council may remit all or any of the past or future annual subscriptions of any Ordinary Fellow if they shall think desirable, but the reason for such remission shall be stated in the resolution by which it is granted.

25. Every Ordinary Fellow who may desire to compound for his future annual subscriptions may do so by a payment of thirty guineas; or, if permanently residing out of the United Kingdom, by a payment of three-fourths of such sum. If such last-mentioned Fellow shall subsequently come to reside within the United Kingdom, he shall forthwith pay the remaining one-fourth of such sum.

26. Honorary and Ex-officio Fellows shall not be liable to pay any admission fee or annual subscription.

C. *Privileges.*

27. All Ordinary Fellows shall be entitled to propose candidates for election as Fellows; to be elected, and to nominate Fellows for election, as Members of the Council or as Officers; to introduce one male visitor at any General Meeting; to receive the publications of the Society; and to inspect and use the books, instruments, and other property of the Society, under such regulations as the Council may from time to time determine. All Ordinary Fellows (being males) shall have the right to be present, to state their opinion, and to vote at all General Meetings.

28. No Ordinary Fellow shall vote on any occasion, or be entitled to any of the privileges of a Fellow, until he has signed the declaration and made the payments mentioned in Art. 10, nor if his annual subscription is twelve months in arrear.

29. Honorary Fellows shall have all the privileges of Ordinary Fellows, except those of proposing candidates for election as Fellows, being elected and nominating Fellows for election as Members of the Council or as Officers, receiving the publications of the Society, and voting at General Meetings.

30. Ex-officio Fellows shall have all the privileges of Ordinary

Fellows, except those of proposing candidates for election as Fellows, being elected and nominating Fellows for election as Members of the Council or as Officers, and voting at General Meetings.

D. *Withdrawal and Removal.*

31. Any Fellow may withdraw from the Society after having paid all annual subscriptions due from him, returned any books or other property belonging to the Society in his possession, and given written notice to one of the Secretaries of his desire to withdraw.

32. The Council may remove any Ordinary Fellow from the Society whose annual subscription shall be more than two years in arrear, but before removing him shall serve him with a notice stating the amount of his arrears, and that in the event of non-payment thereof within twenty-eight days he will be liable to be so removed. Such removal shall not prejudice the right of the Society to recover the arrears at any time thereafter.

33. Any Ordinary Fellow who shall have been removed under the provisions of Art. 32 may, on payment of all arrears, be reinstated by the Council.

34. Whenever there may be any other cause to remove any Fellow from the Society, the Council shall propose a resolution to that effect, which shall be read at two successive General Meetings, and suspended in the interval in one of the rooms of the Society. At the second of such meetings a ballot shall be taken, and if two-thirds of the votes shall be in favour of the removal of such Fellow he shall be removed from the Society accordingly.

V. Council.

A. *Election.*

35. The Council shall be elected at the Annual Meeting in each year, at which Meeting all the Members of the Council shall retire from office.

36. The President and Vice-Presidents shall be ineligible for election to their respective offices for more than two years in succession, and four of the twelve Ordinary Members of Council shall in each year be ineligible for re-election as such Ordinary Members.

37. The Council at their meeting in December, shall prepare a list of Fellows to be recommended to the Society for election at the ensuing Annual Meeting, which list shall be read at the General Meeting in January.

38. Any three or more Fellows who shall be desirous of nominating any other Fellow for election may do so by delivering a nomination paper to the Secretaries, duly signed, before the close of such General Meeting.

39. The votes on any election of the Council shall be taken by ballot.

40. The names of all the Fellows nominated shall be printed in one balloting paper, which shall state by whom the nominations are made.

41. Any Fellow may erase any name from the balloting paper, and may insert in place thereof the name of any other duly qualified Fellow.

42. If for any reason a new Council shall not be elected at the Annual Meeting, the Council for the time being shall continue in office for the year ensuing, or until a new Council shall be elected by a Special General Meeting, and if the place of any Officer or Ordinary Member of Council is not filled up the Council shall have power to fill such vacancy.

43. If in the interval between any two Annual Meetings the place of any Officer or Ordinary Member of Council shall become vacant, the Council shall have power to fill such vacancy.

B. *Proceedings.*

44. The Council shall hold their Meetings at such times as they may appoint.

45. Meetings may be called at any time by the President or by three other Members.

46. Five Members shall constitute a quorum, and if within half an hour from the time appointed for the Meeting a quorum be not present, the Meeting shall be dissolved.

47. In the absence of the President and Vice-Presidents from any meeting, the Members shall choose one of their number to take the Chair, and such Member shall, for the time being, have all the authority and privileges of the President.

48. The votes on any question before the Council shall be by show of hands, unless a ballot shall be demanded by any two Members.

49. The decision of the majority of Members voting at any Meeting shall be considered as the decision of the Meeting.

50. The Council may, from time to time, appoint any Members of their body to be a Committee to deal with any matter referred to it. Any such Committee shall conform to any regulations that may be imposed on it by the Council.

51. No resolution of the Council shall be rescinded by a subsequent Meeting, unless notice of the intention to propose such rescission shall have been sent to the Members one week prior to the subsequent Meeting.

52. The common seal of the Society shall not be affixed to any document, except at a meeting of the Council and pursuant to a resolution duly passed thereat; and such document shall then be signed by the President, Vice-President, or other Chairman of such meeting, and by one of the Secretaries.

53. At the commencement of each year the Council shall prepare a Report on the affairs of the Society for the preceding year.

VI. Officers.

A. *President and Vice-Presidents.*

54. The President shall take the Chair at all meetings of the Society or Council, and shall regulate the proceedings thereat. He shall be a member of all Committees appointed by the Council or by any General Meeting.

55. In the case of an equality of votes at any Meeting, the President shall be entitled to a second or casting vote.

56. In the absence of the President from any Meeting, it shall be the duty of one of the Vice-Presidents to take the Chair, and he shall for the time being have all the authority and privileges of the President.

B. *Treasurer.*

57. The Treasurer shall receive all moneys due to the Society, and shall pay therefrom only such amounts as may be ordered by the Council.

58. All moneys received by the Treasurer shall be paid by him to the Society's Bankers, a sum not exceeding 20*l.* being retained for the payment of current expenses.

59. The Treasurer shall keep an account of his receipts and payments, and shall produce the same whenever required by the Council.

60. The Treasurer shall lay before the Council at their meeting in January a list of all Ordinary Fellows in arrear of their annual subscriptions.

61. Two Ordinary Fellows, one a member, and the other not a member of the Council, shall be appointed at the General Meeting in January to audit the Treasurer's account for the past year. They shall have the power of calling for all necessary books, papers, vouchers, and information.

62. The account so audited shall be signed by the Auditors, and laid before the next succeeding Annual Meeting.

C. *Secretaries.*

63. The Secretaries shall take, or cause to be taken, minutes of the proceedings of all Meetings, and produce and read them at the ensuing Meetings; they shall conduct the business and correspondence of the Society; and shall discharge all such other duties as are usually discharged by Secretaries of Scientific Societies.

64. The Council may appoint an Assistant Secretary and Librarian, and assign to him such duties as it may think desirable, at such remuneration as it may deem proper.

VII. General Meetings.

65. The General Meetings shall be of three kinds—Ordinary, Annual, and Special.

66. Ten Ordinary Fellows shall constitute a quorum, and if within half an hour from the time appointed for the Meeting a quorum shall not be present, the Meeting shall be dissolved.

67. In the absence of the President and Vice-Presidents, the Members of Council present shall choose one of their number to take the Chair, or if no such member shall be present, the Meeting may elect any Ordinary Fellow present to take the Chair, and the Fellow so presiding shall for the time being have all the authority and privileges of the President.

68. All votes shall be taken by show of hands, except in the cases where by these Bye-Laws it is provided that votes shall be taken by ballot.

69. The decision of the majority of Fellows voting at any Meeting shall be considered as the decision of the Meeting.

70. The President, Vice-President, or other Chairman may, with the consent of the Meeting, adjourn any Meeting from time to time and from place to place, but no business shall be transacted at any adjourned Meeting other than the business left unfinished at the Meeting from which the adjournment took place.

71. At any Meeting a declaration by the Chairman that a resolution has been passed or lost, and an entry to that effect in the Minute-Book of the Society, shall be sufficient evidence of the fact, and in the case of a resolution requiring any particular majority, that it was passed by the majority required, without proof of the number or proportion of the votes recorded in favour of or against such resolution.

72. Minutes shall be made in a book provided for that purpose of all resolutions and proceedings of General Meetings, and any such minutes, if signed by any person purporting to be the Chairman of the Meeting to which they relate, or by any person present thereat and appointed by the Council to sign the same in his place, shall be received as conclusive evidence of the facts therein stated.

73. Visitors may be present at any Meeting if introduced by Fellows, and provided they sign their names in the Attendance Book.

A. *Ordinary.*

74. The Ordinary Meetings of the Society shall be held at 8 o'clock P.M. on the second Wednesday in each month, from October to January, and March to June inclusive.

75. The ordinary course of business shall be as follows :—

1st. The minutes of the proceedings of the previous Meeting shall be read, submitted for approval, and if approved, signed by the President, Vice-President, or other Chairman of the Meeting.

2nd. The certificates of candidates for election shall be read and the ballot for the election of Fellows shall take place.

3rd. The donations received since the last Meeting shall be announced.

4th. The objects exhibited shall be described.

5th. Scientific communications shall be read and discussed.

6th. Any other business connected with the affairs of the Society shall be transacted which can be properly transacted at an Ordinary Meeting.

76. No question relating to the Bye-Laws or the management or affairs of the Society shall be discussed or voted upon at any Ordinary Meeting.

B. *Annual.*

77. The Annual Meeting shall be held at 8 o'clock P.M. on the second Wednesday in February.

78. Scientific communications shall not be read or discussed at the Annual Meeting, but in lieu thereof the following shall be the ordinary course of business, in addition to the matters Nos. 1 to 4 in Art. 75.

5th. The Report of the Council for the past year shall be read by one of the Secretaries.

6th. The Treasurer shall read an account of his receipts and payments during the past year.

7th. The Ballot shall take place for the election of the Council for the ensuing year.

8th. Any alteration proposed in the Bye-Laws of the Society shall be discussed and, if necessary, voted on.

9th. The President shall read his Annual Address.

10th. Any other business connected with the affairs of the Society shall be transacted which can be properly transacted at an Annual Meeting.

79. The President, Vice-President, or other Chairman shall appoint two Scrutineers from among the Ordinary Fellows present, not being members of the Council or nominated for election thereto, to take the ballot for the election of the Council.

80. The Scrutineers shall receive the balloting papers from the Fellows present and entitled to vote, and shall report the names of the Fellows elected and the number of votes to the President, Vice-President, or other Chairman, who shall thereupon announce the names of the persons elected.

81. Any balloting paper containing a greater number of names for any office than the number to be elected thereto shall be rejected by the Scrutineers.

C. *Special.*

82. The Council may at any time convene a Special General Meeting.

83. Any ten Ordinary Fellows may, by a requisition in writing signed by them specifying the object of the Meeting, require a Special General Meeting to be held for the purpose of discussing and voting upon any question relating to the Bye-Laws or the management or affairs of the Society; and the Secretaries, upon receiving such a requisition, shall call a Meeting accordingly.

84. One week's notice at least of every Special General Meeting shall be given, either by announcing the same at the Ordinary Meeting immediately preceding the Special Meeting, or by notice in writing served upon the Ordinary Fellows as hereinafter provided. Such notice shall state the place, day, and hour of meeting, and the general nature of the business for which the Meeting is called, and no other business shall be brought forward thereat.

VIII. Library and Cabinet.

85. The books, instruments, and other property of the Society may be inspected and used by the Fellows, under such regulations as the Council may from time to time determine.

86. No instruments or other property, except books, shall be taken out of the Society's rooms without the permission of the Council.

87. A Catalogue of the contents for the time being of the Library and Cabinet, and of the other property of the Society, shall be kept by the Librarian, who shall also keep a list of all donations to the Society, and of all property borrowed by the Fellows.

IX. Papers and Publications.

88. All papers shall be approved by the Council previously to being read at any Meeting, but such approval shall not be taken as expressing any opinion upon any of the statements contained in such papers.

89. Papers shall be read in such order as the Council shall think fit.

90. The Society shall in all cases have the right to publish any paper read, or taken as read, at any Meeting.

91. Papers shall be published either in the Journal of the Society, or in such other manner as the Council shall think fit.

92. The copyright of a paper (and of the drawings, if any, accompanying it) read, or taken as read, at any Meeting shall be the property of the Society, unless the author at the time of sending the same shall stipulate to the contrary, and provided that the Society publish the same within six months after its receipt.

93. The authors of papers published by the Society shall be entitled to such number of copies thereof as the Council shall from time to time determine.

94. The Council may present copies of any of the publications of the Society to, or exchange the same with, such persons and Societies as they may think fit.

X. Notices.

95. A Notice may be served upon any Fellow either personally or by sending it through the post in a prepaid letter addressed to such Fellow at his last known address.

96. Any notice sent by post shall be deemed to have been served on the day following that on which it was posted; and in proving such service it shall be sufficient to prove that the notice was properly addressed and posted.

97. Any Fellow residing at any place not within the Postal Union may name an address within the Postal Union at which all notices shall be served upon him, and all notices served at such address shall be deemed to be well served. If he shall not have named such an address, he shall not be entitled to any notices or to receive any of the publications of the Society.

XI. Alteration of Bye-Laws.

98. No alteration in the Bye-Laws of the Society shall be discussed or made, except at an Annual Meeting, or at a Special General Meeting convened for the purpose.

99. Notice of every alteration proposed to be made in the Bye-Laws shall be given either by announcing the same at the Ordinary or Annual Meeting immediately preceding the Meeting at which the alteration is intended to be proposed, or by notice in writing served upon the Ordinary Fellows as hereinbefore provided.

XII. Interpretation.

100. In the construction of these Bye-Laws words denoting the singular number only shall include the plural number also, and *vice versâ*, and words denoting the masculine gender only shall include the feminine gender also, unless there be something in the context inconsistent therewith.

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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I.—APERTURE TABLE.

Numerical Aperture. ($n \sin u = a$)	Corresponding Angle ($2u$) for Air ($n = 1{\cdot}00$).	Corresponding Angle ($2u$) for Water ($n = 1{\cdot}33$).	Corresponding Angle ($2u$) for Homogeneous Immersion ($n = 1{\cdot}52$).	Limit of Resolving Power, in Lines to an Inch. White Light. ($\lambda = 0{\cdot}5269\ \mu$, Line E.)	Limit of Resolving Power, in Lines to an Inch. Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\ \mu$, Line F.)	Limit of Resolving Power, in Lines to an Inch. Photography. ($\lambda = 0{\cdot}4000\ \mu$, near Line h.)	Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
1·52	..	..	180° 0′	146,543	158,845	193,037	2·310	·658
1·51	..	..	166° 51′	145,579	157,800	191,767	2·280	·662
1·50	..	..	161° 23′	144,615	156,755	190,497	2·250	·667
1·49	..	..	157° 12′	143,651	155,710	189,227	2·220	·671
1·48	..	..	153° 39′	142,687	154,665	187,957	2·190	·676
1·47	..	..	150° 32′	141,723	153,620	186,687	2·161	·680
1·46	..	..	147° 42′	140,759	152,575	185,417	2·132	·685
1·45	..	..	145° 6′	139,795	151,530	184,147	2·103	·690
1·44	..	..	142° 39′	138,830	150,485	182,877	2·074	·694
1·43	..	..	140° 22′	137,866	149,440	181,607	2·045	·699
1·42	..	..	138° 12′	136,902	148,395	180,337	2·016	·704
1·41	..	..	136° 8′	135,938	147,350	179,067	1·988	·709
1·40	..	..	134° 10′	134,974	146,305	177,797	1·960	·714
1·39	..	..	132° 16′	134,010	145,260	176,527	1·932	·719
1·38	..	..	130° 26′	133,046	144,215	175,257	1·904	·725
1·37	..	..	128° 40′	132,082	143,170	173,987	1·877	·739
1·36	..	..	126° 58′	131,118	142,125	172,717	1·850	·735
1·35	..	..	125° 18′	130,154	141,080	171,447	1·823	·746
1·34	..	..	123° 40′	129,189	140,035	170,177	1·796	·741
1·33	..	180° 0′	122° 6′	128,225	138,989	168,907	1·769	·752
1·32	..	165° 56′	120° 33′	127,261	137,944	167,637	1·742	·758
1·31	..	160° 6′	119° 3′	126,297	136,899	166,367	1·716	·763
1·30	..	155° 38′	117° 35′	125,333	135,854	165,097	1·690	·769
1·29	..	151° 50′	116° 8′	124,369	134,809	163,827	1·664	·775
1·28	..	148° 42′	114° 44′	123,405	133,764	162,557	1·638	·781
1·27	..	145° 27′	113° 21′	122,441	132,719	161,287	1·613	·787
1·26	..	142° 39′	111° 59′	121,477	131,674	160,017	1·588	·794
1·25	..	140° 3′	110° 39′	120,513	130,629	158,747	1·563	·800
1·24	..	137° 36′	109° 20′	119,548	129,584	157,477	1·538	·806
1·23	..	135° 17′	108° 2′	118,584	128,539	156,207	1·513	·813
1·22	..	133° 4′	106° 45′	117,620	127,494	154,937	1·488	·820
1·21	..	130° 57′	105° 30′	116,656	126,449	153,668	1·464	·826
1·20	..	128° 55′	104° 15′	115,692	125,404	152,397	1·440	·833
1·19	..	126° 58′	103° 2′	114,728	124,359	151,128	1·416	·840
1·18	..	125° 3′	101° 50′	113,764	123,314	149,857	1·392	·847
1·17	..	123° 13′	100° 38′	112,799	122,269	148,588	1·369	·855
1·16	..	121° 26′	99° 29′	111,835	121,224	147,317	1·346	·862
1·15	..	119° 41′	98° 20′	110,872	120,179	146,048	1·323	·870
1·14	..	118° 0′	97° 11′	109,907	119,134	144,777	1·300	·877
1·13	..	116° 20′	96° 2′	108,943	118,089	143,508	1·277	·885
1·12	..	114° 44′	94° 55′	107,979	117,044	142,237	1·254	·893
1·11	..	113° 9′	93° 47′	107,015	115,999	140,968	1·232	·901
1·10	..	111° 36′	92° 43′	106,051	114,954	139,698	1·210	·909
1·09	..	110° 5′	91° 38′	105,087	113,909	138,428	1·188	·917
1·08	..	108° 36′	90° 34′	104,123	112,864	137,158	1·166	·926
1·07	..	107° 8′	89° 30′	103,159	111,819	135,888	1·145	·935
1·06	..	105° 42′	88° 27′	102,195	110,774	134,618	1·124	·943
1·05	..	104° 16′	87° 24′	101,231	109,729	133,348	1·103	·952
1·04	..	102° 53′	86° 21′	100,266	108,684	132,078	1·082	·962
1·03	..	101° 30′	85° 19′	99,302	107,639	130,808	1·061	·971
1·02	..	100° 10′	84° 18′	98,338	106,593	129,538	1·040	·980
1·01	..	98° 50′	83° 17′	97,374	105,548	128,268	1·020	·990
1·00	180° 0′	97° 31′	82° 17′	96,410	104,503	126,998	1·000	1·000
0·99	163° 48′	96° 12′	81° 17′	95,446	103,458	125,728	·980	1·010
0·98	157° 2′	94° 56′	80° 17′	94,482	102,413	124,458	·960	1·020
0·97	151° 52′	93° 40′	79° 18′	93,518	101,368	123,188	·941	1·031
0·96	147° 29′	92° 24′	78° 20′	92,554	100,323	121,918	·922	1·042
0·95	143° 36′	91° 10′	77° 22′	91,590	99,278	120,648	·903	1·053
0·94	140° 6′	89° 56′	76° 24′	90,625	98,233	119,378	·884	1·064
0·93	136° 52′	88° 44′	75° 27′	89,661	97,188	118,108	·865	1·075
0·92	133° 51′	87° 32′	74° 30′	88,697	96,143	116,838	·846	1·087
0·91	131° 0′	86° 20′	73° 33′	87,733	95,098	115,568	·828	1·099
0·90	128° 19′	85° 10′	72° 36′	86,769	94,053	114,298	·810	1·111
0·89	125° 45′	84° 0′	71° 40′	85,805	93,008	113,028	·792	1·124
0·88	123° 17′	82° 51′	70° 44′	84,841	91,963	111,758	·774	1·136

APERTURE TABLE—*continued.*

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	White Light. ($\lambda = 0{\cdot}5269\,\mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\,\mu$, Line F.)	Photography. ($\lambda = 0{\cdot}4000\,\mu$, near Line *h*.)		
0·87	120° 55′	81° 42′	69° 49′	83,877	90,918	110,488	·757	1·149
0·86	118° 38′	80° 34′	68° 54′	82,913	89,873	109,218	·740	1·163
0·85	116° 25′	79° 37′	68° 0′	81,949	88,828	107,948	·723	1·176
0·84	114° 17′	78° 20′	67° 6′	80,984	87,783	106,678	·706	1·190
0·83	112° 12′	77° 14′	66° 12′	80,020	86,738	105,408	·689	1·205
0·82	110° 10′	76° 8′	65° 18′	79,056	85,693	104,138	·672	1·220
0·81	108° 10′	75° 3′	64° 24′	78,092	84,648	102,868	·656	1·235
0·80	106° 16′	73° 58′	63° 31′	77,128	83,603	101,598	·640	1·250
0·79	104° 22′	72° 53′	62° 38′	76,164	82,558	100,328	·624	1·266
0·78	102° 31′	71° 49′	61° 45′	75,200	81,513	99,058	·608	1·282
0·77	100° 42′	70° 45′	60° 52′	74,236	80,468	97,788	·593	1·299
0·76	98° 56′	69° 42′	60° 0′	73,272	79,423	96,518	·578	1·316
0·75	97° 11′	68° 40′	59° 8′	72,308	78,378	95,248	·563	1·333
0·74	95° 28′	67° 37′	58° 16′	71,343	77,333	93,979	·548	1·351
0·73	93° 46′	66° 34′	57° 24′	70,379	76,288	92,709	·533	1·370
0·72	92° 6′	65° 32′	56° 32′	69,415	75,242	91,439	·518	1·389
0·71	90° 28′	64° 32′	55° 41′	68,451	74,197	90,169	·504	1·408
0·70	88° 51′	63° 31′	54° 50′	67,487	73,152	88,899	·490	1·429
0·69	87° 16′	62° 30′	53° 59′	66,523	72,107	87,629	·476	1·449
0·68	85° 41′	61° 30′	53° 9′	65,559	71,062	86,359	·462	1·471
0·67	84° 8′	60° 30′	52° 18′	64,595	70,017	85,089	·449	1·493
0·66	82° 36′	59° 30′	51° 28′	63,631	68,972	83,819	·436	1·515
0·65	81° 6′	58° 30′	50° 38′	62,667	67,927	82,549	·423	1·538
0·64	79° 36′	57° 31′	49° 48′	61,702	66,882	81,279	·410	1·562
0·63	78° 6′	56° 32′	48° 58′	60,738	65,837	80,009	·397	1·587
0·62	76° 38′	55° 34′	48° 9′	59,774	64,792	78,739	·384	1·613
0·61	75° 10′	54° 36′	47° 19′	58,810	63,747	77,469	·372	1·639
0·60	73° 44′	53° 38′	46° 30′	57,846	62,702	76,199	·360	1·667
0·59	72° 18′	52° 40′	45° 40′	56,881	61,657	74,929	·348	1·695
0·58	70° 54′	51° 42′	44° 51′	55,918	60,612	73,659	·336	1·724
0·57	69° 30′	50° 45′	44° 2′	54,954	59,567	72,389	·325	1·754
0·56	68° 6′	49° 48′	43° 14′	53,990	58,522	71,119	·314	1·786
0·55	66° 44′	49° 51′	42° 25′	53,026	57,477	69,849	·303	1·818
0·54	65° 22′	47° 54′	41° 37′	52,061	56,432	68,579	·292	1·852
0·53	64° 0′	46° 58′	40° 48′	51,097	55,387	67,309	·281	1·887
0·52	62° 40′	46° 2′	40° 0′	50,133	54,342	66,039	·270	1·923
0·51	61° 20′	45° 6′	39° 12′	49,169	53,297	64,769	·260	1·961
0·50	60° 0′	44° 10′	38° 24′	48,205	52,252	63,499	·250	2·000
0·48	57° 22′	42° 18′	36° 49′	46,277	50,162	60,959	·230	2·083
0·46	54° 47′	40° 28′	35° 15′	44,349	48,072	58,419	·212	2·174
0·45	53° 30′	39° 33′	34° 27′	43,385	47,026	57,149	·203	2·222
0·44	52° 13′	38° 38′	33° 40′	42,420	45,981	55,879	·194	2·273
0·42	49° 40′	36° 49′	32° 5′	40,492	43,891	53,339	·176	2·381
0·40	47° 9′	35° 0′	30° 31′	38,564	41,801	50,799	·160	2·500
0·38	44° 40′	33° 12′	28° 57′	36,636	39,711	48,259	·144	2·632
0·36	42° 12′	31° 24′	27° 24′	34,708	37,621	45,719	·130	2·778
0·35	40° 58′	30° 30′	26° 38′	33,744	36,576	44,449	·123	2·857
0·34	39° 44′	29° 37′	25° 51′	32,779	35,531	43,179	·116	2·941
0·32	37° 20′	27° 51′	24° 18′	30,851	33,441	40,639	·102	3·125
0·30	34° 56′	26° 4′	22° 46′	28,923	31,351	38,099	·090	3·333
0·28	32° 32′	24° 18′	21° 14′	26,995	29,261	35,559	·078	3·571
0·26	30° 10′	22° 33′	19° 42′	25,067	27,171	33,019	·068	3·846
0·25	28° 58′	21° 40′	18° 56′	24,103	26,126	31,749	·063	4·000
0·24	27° 46′	20° 48′	18° 10′	23,138	25,081	30,479	·058	4·167
0·22	25° 26′	19° 2′	16° 38′	21,210	22,991	27,940	·048	4·545
0·20	23° 4′	17° 18′	15° 7′	19,282	20,901	25,400	·040	5·000
0·18	20° 44′	15° 34′	13° 36′	17,354	18,811	22,860	·032	5·555
0·16	18° 24′	13° 50′	12° 5′	15,426	16,721	20,320	·026	6·250
0·15	17° 14′	12° 58′	11° 19′	14,462	15,676	19,050	·023	6·667
0·14	16° 5′	12° 6′	10° 34′	13,498	14,630	17,780	·020	7·143
0·12	13° 47′	10° 22′	9° 4′	11,570	12,540	15,240	·014	8·333
0·10	11° 29′	8° 38′	7° 34′	9,641	10,450	12,700	·010	10·000
0·08	9° 11′	6° 54′	6° 3′	7,713	8,360	10,160	·006	12·500
0·06	6° 53′	5° 10′	4° 32′	5,785	6,270	7,620	·004	16·667
0·05	5° 44′	4° 18′	3° 46′	4,821	5,225	6,350	·003	20·000

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103	2 inches	10	1 10 0	22	36	67	90	112
104	2 inches	17	2 10 0					
105	1½ inch	23	2 10 0	30	48	90	120	150
106	⅔ inch	25	2 0 0	70	112	210	280	350
107	⅔ inch	32	2 10 0					
108	½ inch	45	2 10 0	100	160	300	400	500
109	$\frac{4}{10}$ inch	65	4 0 0	125	200	375	500	625
110	$\frac{4}{10}$ inch	95	5 0 0	150	240	450	600	750
111	¼ inch	75	3 10 0	200	320	600	800	1000
112	$\frac{1}{5}$ inch	120	4 10 0	250	400	750	1000	1250
113	⅛ inch	130	5 0 0	400	640	1200	1600	2000
114	$\frac{1}{10}$ imm.	180	5 5 0	500	800	1500	2000	2500
115	$\frac{1}{15}$ imm.	180	8 0 0	750	1200	2250	3000	3750
116	$\frac{1}{20}$ imm.	180	10 0 0	1000	1600	3000	4000	5000
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154	¼ inch	80	1 5 0	170	220	415
155	$\frac{1}{6}$ inch	110	2 5 0	250	330	630
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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY 1888.

TRANSACTIONS OF THE SOCIETY.

I.—*Fresh-water Algæ (including Chlorophyllous Protophyta) of the English Lake District.* II. *With descriptions of a new genus and five new species.*

By Alfred W. Bennett, F.R.M.S., F.L.S., Lecturer on Botany at St. Thomas's Hospital.

(*Read 11th January*, 1888.)

Plate I.

The following is a list of species gathered in the English Lake District in August and the early part of September 1887, not included in my previous list from the same district.* A few species only are noted which are recorded in that list, where it seemed desirable for some special reason, and these are placed between brackets. The gatherings were all within the county of Cumberland, in the lower part of Borrowdale, and near the southern end of Derwentwater, mostly

EXPLANATION OF PLATE I.

Figs. 1–3.—Hormospora mutabilis Bréb. × 200.
„ 4.—Acanthococcus anglicus Benn. × 200.
„ 5.—Urococcus insignis Hass. (?) × 400.
„ 6.—Capsulococcus crateriformis Benn. Tegument with single pseudocyst, front view × 200.
„ 7. „ „ „ Tegument with nest of eight pseudocysts, front view × 200.
„ 8. „ „ „ Empty tegument, side view × 200.
„ 9.—Chroococcus pyriformis Benn. × 200.
„ 10.—Gomphosphæria (?) anomala Benn. × 200.
„ 11.—Calothrix minuta Benn. × 200.
„ 12.—Gonatozygon Brebissonii dBy (?) × 200.
„ 13.—Euastrum rostratum Ralfs, var. cumbricum Benn. × 400.
„ 14.—Cosmarium globosum Buln. × 400.
„ 15.—Staurastrum spongiosum Bréb., var. cumbricum Benn., side view × 400.
„ 16. „ „ „ „ „ front view × 400.

* This Journal, 1886, pp. 1–15.

from bog pools at a comparatively low elevation. On the whole, they were not so rich as those made in the Loughrigg district, but some interesting forms were obtained.*

PROTOPHYTA.

Protococcaceæ (including Palmellaceæ).

Glœocystis ampla Ktz.
Scenedesmus obtusus Mey.
Homospora mutabilis Bréb. Figs. 1–3.

As, according to Dr. Cooke, this interesting plant has at present been observed only in Ireland, as far as these islands are concerned, a figure is appended. The completely unbranched gelatinous sheath is about 37·5 μ in diameter, and rounded at both ends, usually quite straight, but sometimes with a knee-shaped bend, as in fig. 1. The pseudocysts are globular or elliptical, about 20–25 μ long by 15–20 μ broad, with bright green and strongly granular endochrome, frequently exhibiting rudimentary transverse bipartition (fig. 2). They are either in close contact or with an evident space between them. In only one instance (fig. 3) were the pseudocysts seen in two rows within the sheath. It was observed only in gatherings from a bog pool near the Bowder-stone, but was there abundant.

Acanthococcus anglicus n. sp. Fig. 4.

Of this interesting genus, first separated by Lagerheim, as many as fourteen species have been described and figured by Reinsch.† I have already noted (see this Journal, 1887, p. 12) the occurrence of several of these forms in this country; the one now described I am unable to identify with any of Reinsch's species. It occurs in isolated individuals, the stiffly gelatinous or cellulose membrane of which is irregularly spherical, varying between 65 and 95 μ in diameter, and is distinctly laminated or folded in several layers, and prolonged into long slender colourless protuberances, from one-third to two-fifths the diameter of the globe. These spines are sufficiently solid to be distinctly bent by passing diatoms or animalcules, thus being clearly distinguished from the very much more fluid envelope which, in some desmids, is also not unfrequently raised into spine-like prominences. The cell-contents are bright green and granular. This species corresponds very closely in size and in the structure of the cell-membrane with Reinsch's *A. insignis*, which, however, is described as without spines; but I cannot but think it probable that they are different stages or conditions of the same organism. It is larger than any of Reinsch's spined species, coming nearest to *A. Hystrix*, but differs also in the nature of the cell-wall. At first sight it resembles *Eremosphæra viridis* dBy., but is somewhat smaller, and at once distinguished by

* The names of new species are printed in small capitals; those of species new to Britain in *italics*.

† Ber. Deutsch. Bot. Gesell., 1886, pp. 237–44.

its very distinctly spiny envelope. It is endowed with a slow motion, not in any way connected with the spines. It was observed only very sparsely in a sphagnum bog in Borrowdale.

Urococcus insignis Hass. (?) Fig. 5.

Pseudocyst large, solitary, nearly globular, of a brick-red colour, from 28 to 35 μ in diameter, inclosed in a colourless gelatinous sheath composed of a number of rings, which form a short stem. The species described under this name has been observed only by Hassall, and as he gives no measurements, it is impossible to identify with certainty my plant with his, but it appears to agree. It is larger than *U. Hookerianus* Hass., the only species of which Dr. Cooke gives measurements, and differs in other respects from the remaining species recorded as British. Bog pools, Borrowdale; very scarce.

Capsulococcus n. gen. Protococcacearum.

Cellulæ virides, globosæ, solitariæ vel 2–8 in familias associatæ, tegumento lamelloso, firmo vel subgelatinoso, subgloboso vel ovoideo, crateriformi, fusco, denique subsolido.

Capsulococcus crateriformis n. sp. Figs. 6–8.

Pseudocyst large, bright green, usually solitary (fig. 6), and then from 20–25 μ in diameter, or even more, globular or elliptical; or divided into a nest of 2–8 smaller pseudocysts (fig. 7). Tegument a lighter or darker brown, lamellose, nearly globular or ovoid in general outline (fig. 8), varying in diameter from 25 to 75 or 80 μ, but with a deep round saucer-shaped depression (at one end when the tegument is ovoid), with very sharply defined rim. At the bottom of this depression is seated the single pseudocyst or nest of pseudocysts. The teguments appear to assume a darker and somewhat indurated character after shedding the pseudocysts (fig. 8). Bog pools, Borrowdale; not uncommon.

Characiaceæ.

Dictyosphærium reniforme Buln. Bog pools.

Chroococcaceæ.

Chroococcus pyriformis n. sp. Fig. 9.

Pseudocysts very large, somewhat pear-shaped, 50 μ long by 37·5 μ broad, associated in pairs, and each pair inclosed in a very thin mucilage; the two pseudocysts but slightly attached by their somewhat broader base. Endochrome very bright blue-green, somewhat granular. Pool near Derwentwater.

Cœlosphærium Kützingianum Näg. Frequent.

Gomphosphæria (?) anomala n. sp. Fig. 10.

Tegument quite globular, well-defined, from 110 to 120 μ in diameter, composed of perfectly colourless and transparent mucilage.

Pseudocysts light blue-green; those near the periphery of the tegument comparatively large, 6–10 μ in diameter, and loosely scattered; those towards the centre much smaller and more crowded. Bog pool near the Bowder-stone; not unfrequent.

I have much hesitation in placing this organism under Kützing's genus *Gomphosphæria*, as its inclusion would require the modification of the character from which the name of the genus is taken, the wedge-shaped form of the pseudocysts. On the other hand, it shows a striking resemblance in the interspersal of a large number of minute pseudocysts among a smaller number of larger peripheral ones. If this is regarded as the more important character, the diagnosis of the genus will have to be modified accordingly.

Aphanocapsa montana Cram. Bog pools; not unfrequent.

OSCILLARIACEÆ.

Oscillaria princeps Vauch. Occasional.
Symploca Ralfsiana Ktz. Among *Sphagnum*.

SCYTONEMACEÆ.

Tolypothrix ægagropila Ktz. Bog pools.
„ flaccida Ktz. Bog pools.

RIVULARIACEÆ.

CALOTHRIX MINUTA n. sp. Fig. 11.

Sheaths about 12·5–20 μ in diameter, and 2–6 times as long as broad, yellowish-brown, several grouped together in tufts. Filaments several within each sheath, excessively fine, moniliform, very pale blue-green. Heterocysts basal, colourless, visible within the sheath. Bog pool, Borrowdale; seen only floating, but probably attached in tufts to other algæ.

NOSTOCACEÆ.

Anabæna flos-aquæ Ktz.
[Nostoc hyalinum Benn. Occasional.]

ALGÆ.

PEDIASTREÆ.

Pediastrum rotula Br.

SORASTREÆ.

Sorastrum bidentatum Reinsch.

PANDORINEÆ.

Eudorina elegans Ehrb.
Gonium pectorale Müll.

DESMIDIEÆ.

Sphærozosma pulchellum Rabh.

Hitherto, according to Dr. Cooke, not observed in Great Britain.

Docidium granulatum Benn. (in Journ. R. Micr. Soc., 1887, p. 8). Occasional.

Gonatozygon Brebissonii dBy (?). Fig. 12.

Cells perfectly straight, very long and slender, 24–30 times as long as broad, 7·5 μ broad, 190–230 μ long, very nearly uniform in diameter throughout, with slightly dilated and truncate extremities, and no constriction in the centre. Endochrome homogeneous, with a single row of from 20–24 vesicles down the centre; extremities and small space in centre colourless. The whole clothed with short very thickly-set spines or hairs.

I am somewhat doubtful about this identification, as I only saw the cells detached, and not united into filaments, and as also it was not seen in conjugation. It differs also somewhat in size from the description and figures, being longer and narrower. Bog pools, Borrowdale; occasional.

Closterium rostratum Ehrb.

„ lineatum Ehrb.

„ setaceum Ehrb. Pool near Derwentwater.

[Micrasterias papillifera Bréb.]

The character given in text-books—"Frond bordered by a row of minute granules"—is by no means accurate in all cases; as often as not I find them scattered over the whole surface of the frond.

Micrasterias angulosa Hantsch.

Euastrum humerosum Ralfs.

„ Jenneri Arch. Frequent.

„ rostratum Ralfs., var. CUMBRICUM n. var. Fig. 13.

About the size of the typical form, but narrower in proportion to its length; average length 45–50 μ, breadth 25 μ; the outline nearly rectangular; each segment with two rounded lobes, each projecting about as far as the blunt terminal beak; terminal lobe rather deeply divided at the apex. A single large prominence near the centre of each segment. Bog pools; frequent.

Cosmarium bioculatum Bréb.

„ pygmæum Arch.

„ Wittrockii Lund. Frequent.

Cosmarium globosum Buln. Fig. 14.

Minute; outline elliptical; length 20–30 μ; breadth 15–20 μ; segments sub-reniform; sinus acute. Endochrome homogeneous, without vesicles; cell-wall not punctated. Bog pools; frequent.

Cosmarium quadrum Lund.

This fine species was found in one gathering only.

Cosmarium Broomei Thw.
„ sphericum Benn. (in Journ. R. Micr. Soc., 1887, p. 10). Occasional.
„ ochthodes Nords.
[„ speciosum Lund. Occasional.]
Calocylindrus annulatus dBy. Bog pools; not unfrequent.
Xanthidium antilopeum Bréb. Bog pools; occasional.

No British locality is given by Dr. Cooke, but it has been gathered in this district by Mr. Bisset.

Xanthidium cristatum Bréb.
Arthrodesmus octocornis Ehrb.
Staurastrum armigerum Bréb.
„ spongiosum Bréb., var. CUMBRICUM n. var. Figs. 15, 16.

Side view somewhat longer than broad, about 60 μ long, 50 μ wide; each segment elliptical, with an oval protuberance in front, covered with hyaline bifurcate processes. Front view triangular, with slightly convex sides and obtuse angles, about 48–52 μ in diameter, completely covered with bifurcate hyaline processes. Slightly larger than the typical form, not so orbicular in outline, and distinguished by the protuberance on each segment. Moss pool, Grange-in-Borrowdale.

Staurastrum pygmæum Bréb.

Length 23 μ; breadth 26 μ; each segment nearly elliptical. Pool near Derwentwater.

Staurastrum tumidum Bréb.

This fine desmid was not unfrequently seen; always inclosed in dense hyaline jelly.

Staurastrum cornubiense Benn. (in Journ. R. Micr. Soc., 1887, p. 11).
„ brachiatum Ralfs.
„ tricorne Bréb.
„ inflexum Bréb.
„ paradoxum Mey.
„ proboscideum Bréb.
„ aculeatum Menegh.

ZYGNEMACEÆ.

Zygnema pectinatum Ag.

MESOCARPEÆ.

Staurospermum capucinum Ktz.

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West Newman & Sons lith.

II.—*Note on Micrasterias americana, Ralfs, and its Varieties.*

By W. M. Maskell, F.R.M.S.

(*Read 14th December*, 1887.)

Plate II.

Since the publication of Mr. Ralfs's work on the British Desmidieæ, its author must have been pleased to observe the great extension which the study of these beautiful little organisms has received. From 1848 until the present day, scarcely a year has gone by without an increase in the number of species and of the works relating to them, so that in fact the list of writers on desmids is now quite of respectable, even formidable length, and the study of these plants is getting to be almost as complicated and difficult as that of diatoms. The time has arrived when a comprehensive monograph of the family is not only desirable but necessary.

The present note has been prepared in anticipation of such a work. Simplification is, I take it, much to be desired in all scientific manuals, and especially so in these days of almost infinite subdivision and specialization of observation. So close and minute is nowadays the examination of the minuter forms of animal and vegetable life, so careful is the diagnosis of each, so numerous are the workers in nearly every branch, that the separation of "species," "varieties," and "forms," has become almost unbearably multiplied: differences so slight as to be apparent only to the very closest scrutiny are necessarily looked on as sufficient distinctions, and the student is wearied, confused, and perhaps frightened, by the infinite labours entailed upon him. Not only so; he is also puzzled by the fact (at least in the microscopic forms) that there is no absolute uniformity even in things which he has considered identical. A desmid, for example (I speak from my own observation) kept in a growing cell for some days, will undergo minute changes which it requires a good deal of knowledge of the

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EXPLANATION OF PLATE II.

Fig. 1.—*Micrasterias americana* Ralfs, forma *genuina*.
„ 2. „ „ „ *integra* Turner (forma *b* Rabenhorst).
„ 3. „ „ „ *recta* Wolle.
„ 4. „ „ „ *spinosa* Turner (MS.).
„ 5. „ „ „ *Ralfsii* Turner (forma *β* Ralfs).
„ 6. „ „ „ *major* Wills.
„ 7. „ „ „ *excelsior* Wallich (Turner MS.).
„ 8. „ „ „ *Mahabuleshwarensis* Hobson.
„ 9. „ „ „ *Wallichii* Grunow.
„ 10. „ „ „ *Wallichii* forma *succica* (Turner MS.).
„ 11. „ „ „ *Hermanniana*, Reinsch.
„ 12. „ „ „ *fijiensis* Macdonald.
„ 13. „ „ „ *ampullacea* Maskell.
„ 14. „ „ „ *ampullacea* var. *β* Spencer.

The magnification of these figures is not uniform, as the object has only been to exhibit gradations of outline.

family not to mistake for real variations. Sometimes we attain a position where it may be possible to simplify this, and to reunite under one species, as merely "forms" of it, various plants, whether of one or of different countries, which their discoverers may have considered to be separate. I believe that this can now be done with the desmidian species *Micrasterias americana*.

In a paper of mine in 1880 (Trans. New Zealand Inst., xiii. p. 304), on New Zealand Desmidieæ, I reported the existence of a plant to which I gave the name of *M. ampullacea*, and I indicated that it was nearly allied to *M. americana*. Mr. Archer, in 'Grevillea,' September 1881, referred my plant nearly to *M. Hermanniana* Reinsch. I understand that Professor Nordstedt, of Lund, would include mine and some others under *M. Mahabuleshwarensis* Hobson. My object in writing now is to advocate that all these, and the other cognate forms, should be merely considered as variations of one type species; and I select *M. americana* as the type, because it was the first described.

The outline of *M. americana* was very correctly delineated in Mr. Ralfs's work, first under the name *M. morsa*, afterwards corrected. Since that time, as far as I know, thirteen plants more or less closely resembling the original have been described from various countries. The last of these was reported by Dr. Spencer (Trans. New Zealand Inst., xiv. p. 296 and pl. xxiii.) as a variety of my *M. ampullacea*, and although at first sight there undoubtedly is no very close resemblance between it and Mr. Ralfs' type, yet when all the fourteen plants are placed together, the gradations are seen to be so gradual that they form a regular series. With the object of showing this, I have attached hereto figures of them all in juxtaposition. For most of these figures I am indebted to the kindness of Mr. Barwell Turner. Beginning with the type-species No. 1, it will be seen that the two *lateral* lobes of each segment are broad at their bases, and are cut at their extremities into four short cylindrico-tapering lobules. In the forms 2, 3, 4, and 5, there is not much difference in this respect; No. 2 has its side lobes apparently even widening towards their ends, or rather with an indication of a small fifth lobule on each side which will be useful for comparison presently. In No. 6 the side lobes are evidently narrower and more deeply incised in the middle, giving an approach to the form No. 7, where the incision is deep enough to produce the effect of only two divaricating lobules. This form passes easily into No. 8, and thence into No. 9, where we have a more pronounced extra lobule than in No. 2. From No. 9 the gradation to No. 14 is quite easy; in fact, if it were not for other points to be mentioned presently, all these last forms are almost alike.

In point of fact, judging merely by general outline, the whole series might be divided into two groups: the one including those forms in which the lateral lobes are obscurely bifid; the other, the forms in which they are distinctly bifid. The extra lobule appears

to be accidental, and is here not taken into consideration. The first group would include Nos. 1 to 6; the second Nos. 7 to 14. Even then, when a plant is found which will lessen the apparently more distinct gap between No. 6 and No. 7, the two groups would be merged into one.

There are, however, two other considerations which seem to me to forbid the subdivision into only two groups. The first is the presence or absence of serrations on the middle or terminal lobe; the second is the shape of the lateral lobes and lobules. Whilst anxious, as I remarked just now, for simplification of species and varieties, I believe the convenience of students and observers will be consulted by employing subdivision wherever clearly marked, just as a farmer finds it convenient to separate shorthorns from Devons, or Leicesters from Cheviots. A glance at the accompanying figures will show that there are three different shapes of the lateral lobes and lobules, and three different characters of the edges, whether all round or on the median lobe. I propose therefore the following arrangement as probably correct, and at the same time likely to help a student to identify or to allocate correctly any plant which he may find agreeing with the series.

Micrasterias americana Ralfs.

* Lateral lobes thick, lobules short.

1. Forma *genuina* Ralfs.
2. „ *integra* Turner (forma *b* Rabenhorst).
3. „ *recta* Wolle.
4. „ *spinosa* Turner (MS.).
5. „ *Ralfsii* Turner (forma β Ralfs) MS.
6. „ *major* Wills.

** Lateral lobes with directly-tapering lobules: sides of median lobe smooth.

7. Forma *excelsior* Wallich (Turner MS.).
8. „ *Mahabuleshwarensis* Hobson.
9. „ *Wallichii* Grunow.
10. „ *Wallichii* forma *suecica* (Turner MS.)

*** Lateral lobes with sinuous or flask-like lobules: sides of median lobe smooth.

11. Forma *Hermanniana* Reinsch.
12. „ *fijiensis* Macdonald (1856), perhaps.

**** Lateral lobes with flask-like lobules; sides of median lobe serrated.

13. Forma *ampullacea* Maskell.

***** Lateral lobes with flask-like lobules: margins of all the lobes smooth.

14. Forma *ampullacea* var. β Spencer.

The sketch of Mr. Macdonald's Fijian plant from which my figure has been taken is on too small a scale to show whether the median lobe has a smooth or a rough shaft.

As a matter of strict classification, perhaps, a regular series might be formed from the whole genus *Micrasterias*, even such apparently dissimilar plants as *M. denticulata* Brébisson, and *M. dichotoma* Wolle, which might be placed at opposite poles, exhibiting the generally trilobate form characteristic of the whole series. To some extent the same might be done in other genera, say *Cosmarium*, *Staurastrum*, or *Closterium*; but in these the gradations would not be nearly so easy to find at present. *Micrasterias*, a small genus of few species which run almost into one another, offers a good opportunity for some such simplification as I have endeavoured to effect in one case.

There is, as has been hinted above, a slightly wider gap between my No. 6 and No. 7, than between any two others, and probably this is an inducement to separate my series into two. Still, the gap is so slight that I think it may be disregarded, and it only needs the finding of one specimen of either of these two plants varying the least bit either way, to fill it up as much as in other cases.

The suggestion which I have made may be, perhaps, by some considered trivial, and taken *per se* is of course only interesting to students of the Desmidieæ. Yet I venture to express the thought that it may have a wider bearing, and that future generations of workers in science may not be over-thankful to those who, with the very best intentions, are nowadays multiplying "species" with such exuberant fertility. The remark applies to all branches of zoological and botanical inquiry as far as my experience extends. At the present rate, the papermakers and bookbinders profit greatly, and the shelves groan more and more under the weight of books; but there is prospect of much trouble and weariness for future students.

III.—*Note on the Minute Structure of Pelomyxa palustris.*

By G. Gulliver.

(*Read* 11*th January*, 1888.)

This interesting Protozoon was first described by Greef, and there is a good account of it in Prof. Ray Lankester's article in the 'Encyclopædia Britannica.' It is found in mud at the bottom of pools, often in association with *Amœbæ* and other allied forms. It is distinguished by its large size—for it often attains to a diameter of 1/30 in.—its sluggish movements by means of blunt pseudopodia, and its voracity, the protoplasm having in general much foreign matter in it. On looking at living specimens, it struck me that the minute structure was probably more complicated than might at first be imagined; and the large size of the animal enabled my friend Mr. Pode to cut some sections which form the subject of the few remarks which I wish to make. These sections were exceedingly friable, but portions remain in a sufficiently perfect condition to allow me to demonstrate a few points which I venture to think have not before been sufficiently dwelt upon. My remarks refer first to the exoplasm, and secondly to the endoplasm.

Exoplasm.—Professor Ray Lankester divides the Protozoa into Gymnomyxa and Corticata, the former containing, besides many other forms, *Amœba*, and the genus which is the subject of these remarks, and the latter the higher Protozoa only. The distinction which he makes between the two groups rests upon the statement that a definite cortical layer is present only in the latter. He says, "The distinction into so-called exoplasm and endoplasm recognized by some authors is not founded on a permanent differentiation of substance, but is merely due to the centripetal aggregation of granules lying in a uniform undifferentiated protoplasm. This may be true of many forms, but the sections under the Microscope show that not only is there in *Pelomyxa* a distinction into exoplasm and endoplasm, but that the two, instead of passing into one another gradually, as one would have expected, are sharply defined by a definite boundary, without transitional phases of structure. The exoplasm forms a complete investment to the endoplasm in the form of a layer of uniform thickness apparently composed of delicately reticulated firm protoplasm, containing small vacuoles, and, as I think, devoid of nuclei, such few as are seen being apparently pushed on to its substance from the endoplasm beneath. In the process of hardening, this layer readily separates from the subjacent softer endoplasm. Here and there a large vacuole, and in some cases a diatom or other foreign body can be seen in its substance.

Endoplasm.—This is evidently much softer, more friable, and has its parts more loosely held together than the outer layer. Prof. Lankester speaks of it as composed of a richly vacuolated protoplasm,

containing numerous small nuclei and not a single large nucleus as in the allied *Amœba*. It appears to me, however, that it is in reality composed of a number of nucleated cells loosely held together. What have been taken for vacuoles seem to me to be the delicate translucent cells, the nuclei alone of which are visible in the entire animal, especially when unstained. These cells are about the size of a white blood-corpuscle. Prof. Lankester suggests to me that they, with their nuclei, may be swarm-spores; and though I feel inclined to regard them as the permanent arrangement of the protoplasm, and to look upon the animal as one of those Protozoa which have been described as multicellular, yet without examining other individuals to see how far the structure is permanent, it would be premature to speak definitely.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Animal Ovum.‡—Prof. F. Leydig gives a preliminary notice of the results of his investigations into the egg-cell.

Germinal Rudiment and Egg-follicle.—It is now generally recognized that the egg is from the first a cell, and that it does not commence as a nucleus; the error of observation is due largely to the small quantity of protoplasm which often surrounds the nucleus. As bearing on the question of the affinities of Annelids, Arthropods, and Vertebrates, the author points out that if we can imagine a germ-cord from the stroma of the ovary of a mammal it would have a close resemblance to free cords, such as those of the leech. The earliest mark of differentiation is that the cell-mass divides into germ-cells and matrix-cells, the former becoming the primordial ova, and the latter the follicular cells; these latter excrete cuticular layers, so that the follicular wall becomes thicker and takes on the character of connective tissue. The relation of the secreting matrix-cells and the cuticle to the primordial ova is exactly the same as that which obtains between the ganglionic sphere of a spinal ganglion and the investment. A *membrana granulosa*, or layer between the egg and the follicular wall is, when present, a later addition; the author is inclined to refer its origin to leucocytes and matrix-cells. In *Lithobius* and *Geophilus* leucocytes certainly enter from the stalk of the follicle, while in mammals the elements of the granulosa are derived from the matrix and connective-substance cells of the follicle. The granulosa of a mammal and the follicular epithelium of an insect appear to be corresponding structures.

Egg-cell.—Germinal spots are of two kinds; some have the characters of *Amœbæ* with pale margins, and consist of spongioplasm, hyalo-

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Zool. Anzeig., x. (1887) pp. 608–12, 624–7.

plasm, and nuclear spot; others have a dark margin, a fat-like cortex, and paler contents. Notwithstanding these differences there are some indications of the passage of the former into the latter state. The germinal spots arise from the nodal points of the nuclear framework; when they multiply, the larger germinal spot produces a brood by gemmation and fission; differences are exhibited in different groups of animals. In consequence of their amœboid nature, germinal spots which have become independent are capable of uniting into columns, and it must, therefore, be supposed that the transversely striated cords are not always directly due to the multiplication of germinal spots.

The membrane of the germinal vesicle may present differences in one and the same animal; for example, in *Triton* it may be proportionately thick and perforated, or it may be thin and apparently without pores, and possibly it may disappear altogether.

The name of mantle-layer is applied to a layer of germinal vesicles, first described by Eimer in reptiles; it is only temporarily present, and presents numerous variations; it consists of granules, which look like germinal spots, and are often so grouped as to seem to have a radial striation. An account is promised of observations which seem to show that this layer is connected with processes of germinal spots. Among the general structural relations of the egg we must reckon the cavity around the germinal vesicle, which is filled by a clear, very soft and almost fluid protoplasm; from this space hollow passages extend into the yolk, where they vary considerably in form and direction. This cavity was first noticed by Pflüger.

The germinal vesicle, which is ordinarily spherical, may be seen in the fresh state to exhibit depressions and processes, or pits and lobes, which may be regarded as due to movements. But it must remain uncertain whether this change in form is due to the vesicle itself or to the whole egg-cell.

The yolk consists of spongioplasm and homogeneous hyaloplasm, to which are added vitelline granules and spheres. The spongioplasm is generally a fine closely-felted network, without any regular arrangement, but in others there are pretty regular concentric lines, or radially arranged bands. The intermediate spaces vary in size, but are often very small; in addition to these there may be larger cavities arising from the germinal vesicle, extending through the yolk in a radial manner, and anastomosing with one another. It is erroneous to suppose that the spaces seen by Reichert in the yolk of bony fishes were due to coagula. When larger yolk-spheres appear and become regularly arranged in the periphery of the egg we can distinguish an outer from an inner yolk. It has often been supposed that nuclear and cellular structures may be seen in the yolk, before the commencement of segmentation. These bodies are of two kinds; some resemble germinal spots, while the others are like thickenings of the nodal points of the spongioplasm. The former are really germinal spots, which have passed into the yolk; the others resemble the secondary nuclei of other cells, and of the egg of *Ascaris megalocephala*. As to what becomes of them there is some difficulty, but it seems to be certain that they do not form the material for the membrana granulosa. Prof. Leydig's own observations, supported by those of Heider and Blochmann on Arthropod ova, lead him to suppose that they form a cellular layer round the yolk, but that the boundaries between the cells are not well marked; the "internal

epithelium" of Clark, Eimer, and Klebs, the existence of which has been so often denied, may be due to them. As to the function of the second kind of bodies no suggestion is offered.

Maturity of the Ovum.*—Dr. A. Carini discusses the problem of maturity in the ovum. He refers to the probable importance of the inquiry, as Thury has emphasized, in connection with the determination of sex. In an historical *résumé* he notes the various contributions which from Barry onwards have been made to this subject. Barry referred to the smaller mass of cellular droplets, Wharton Jones to the disappearance of the germinal vesicle. Bischoff emphasized the increase in size, the looser structure of ripe follicles, and the increase of liquor folliculi, while Waldeyer called attention to the richer vascularity of ripe follicles, the differentiation of layers in the granulosa, and the radiate striation of the zona pellucida. His noted the increase of lymph spaces on the wall of the follicle, Hensen emphasized the larger size, the oval form, and the changes of the follicular cells. Von Baer had noted the peripheral position of the nucleus.

Carini has been impressed by the occurrence of eosinophilous elements in the follicles of mature ova. In younger ova, both in nuclei and protoplasm, the follicular cells have most attraction for hæmatoxylin, while eosin staining only sparsely occurs in the protoplasm. He believes that the susceptibility of eosin characteristic of the cells of ripe follicles points to the progress of a degenerative process in these cells.

Axis of Frog Ovum.†—Dr. O. Schultze responds at considerable length to some strictures made by Roux upon his work on frog ova. He reaffirms his old positions, and gives his reasons for doubting the satisfactoriness of some of Roux's experiments. The axis of the ovum corresponds in its course from dark to clear pole to the dorsoventral axis of the embryo. The relation of this axis to the unfertilized egg is the same as in all telolecithal vertebrate ova. From the moment of the oblique posing of the egg after fertilization onwards, since the point lying uppermost in the clear portion represents the position of the blastopore and that of the future tail, the longitudinal axis is fixed; it passes from the point just mentioned at right angles to the transverse axis.

Relation of Medullary Canal and Primitive Streak.‡—Dr. J. Kaczander has investigated the somewhat obscure point of the relations between the primitive streak and the medullary canal. Chick embryos were examined, beginning at the stage when the primitive streak is visible to the naked eye, surrounded anteriorly by the dorsal folds. It was seen that the residue of the streak—unused in the differentiation of the body—includes the solid rudiment of the medullary canal. So far the latter conforms to the rule in passing through a groove-like stage before it is closed into a tube. Similar processes are seen in the bony fishes, where, according to Schapringer, the central canal of the spinal cord arises by a process of splitting within the solid rudiment, or, according to Oellacher, by the divergence and partial dissolution of the innermost cell-layer of the solid rudiment. There is this difference, however, that in the Teleostei the groove-form never occurs, but the tube is formed directly from the solid rod.

* MT. Embryol. Inst. Wien, 1887, pp. 69–77.
† Biol. Centralbl., vii. (1887) pp. 577–88.
‡ MT. Embryol. Inst. Wien, 1887, pp. 26–32.

Spermatogenesis.*—Herr O. S. Jensen studied the ontogeny of spermatozoa in the rat, horse, sheep, and to some extent in man. His research bears especially on the much debated point of the structure of the tail, but some observations on the head-portion were also made. The fibrillar composition of the axial filament, the apposition and not twisting of the thread-like halves, the lumen passing up the entire axial filament, the spiral thread round the axis-filament in the connecting portion, are all minutely described and figured, but hardly call for detailed summary.

Two Young Human Embryos.† — Prof. J. Janosík has studied a young normal and satisfactorily preserved human embryo. A second less favourable specimen also came into his hands. The first was probably the youngest human embryo as yet satisfactorily described. It measured 3 mm. in length, the ovum itself 8 mm.; the whole surface was covered with villi 1 mm. in length. The relations of the skin, body-wall, skeleton, nervous system, sense organs, alimentary tract, urinogenital organs, heart and vascular system, are described in detail. The embryo described corresponds to the embryo of M. His, which was probably slightly younger, but less well preserved. The relations to other young embryos are also noted.

Experimental Embryology.‡—Prof. L. Gerlach gives an interesting account of a new method applicable to research in the comparatively new field known as experimental embryology.

There can be no doubt that a young form is more in the grasp of environmental influences, and is more plastic towards them than an adult can well be; an influence borne in persistently on a series of generations during embryonic life must be of the most potent character. That experimental embryology has not been earlier attacked has been due on the one hand to the necessity for preliminary study of the normal development, and on the other hand to the absence of a proper method. To attack such a problem as that of testing mutability during embryonic life, it is necessary that accessible embryos be obtained, that some knowledge be forthcoming as to the influence and application of definite, not mortal external agents, and that it be possible to rear the subjects of experiment. As regards accessibility, the ova of birds, amphibia, and fishes are among Vertebrata the forms best adapted for experiment. The external influences, the operation of which may be studied, are manifold, from pressure to electric currents. Under increased pressure, Rauber produced short compressed forms. With over-abundant oxygen, the gills of tadpoles remained rudimentary. The influence of gravity on segmentation has been abundantly studied. Roux has investigated the results of pressure and mechanical injuries.

In spite of these and other important researches, there are many obvious desiderata. It is necessary to have a more exact method of experiment, the varying plasticity of the embryos must be appreciated, a graduated series of influences must be established, and successive generations must be reared. Experiments on the mutability of embryos are still relatively premature, but birds afford the most convenient subjects for experiment as to the operation of external influences and

* Arch. f. Mikr. Anat., xxx. (1887) pp. 379–425 (3 pls.).
† Ibid., pp. 559–95 (2 pls.).
‡ Biol. Centralbl., vii. (1887) pp. 588–605. Anatom. Anzeig., 1887, pp. 18–9.

their transmission under persisting conditions to subsequent generations.

Following the ancient attempts of Beguelin (1749), and numerous more elaborate expedients since proposed, Gerlach introduced an air-tight glass window in an aperture formed by breaking a portion of the egg-shell at the pointed pole. A permanent window was, however, inconvenient for experiment, though most useful for demonstration. After trying half-a-dozen different instruments, Gerlach at length devised the apparatus which he has used for about a year, and which he calls the Embryoscope. Generally, the contrivance consists of a metal ring fastened on the egg-shell, and of an air-tight glass plate covering the space where the shell had been removed within the metal ring. The operation is accomplished with antiseptic precautions. The window can be easily opened and reclosed so that the embryo may be subjected to experimental influences. For demonstration purposes, for watching the differences of growth in various regions, for studying heart-beat and other functions, and above all for investigating the operation of external influences, the device promises to be indispensable. Embryos with such windows have lived as long as thirteen days, over half the period of hatching. On till the fifth day the embryo could be readily brought under the window. When the embryo itself could no longer be directly observed from the window, the circulation of the blood could be caught sight of, and the life of the embryo proved.

Gerlach watched the effect of localized heat and cold, of mechanical pressure, and of chemicals. He watched the appearance of bifurcation or anterior doubling of the heart, and the diminution or entire disappearance of the amnion. By hindering the development of the primitive streak, he tried to find out whether the blood-elements came from mesoderm plates or from parablast. His results were, however, too few and negative to admit of certain conclusion. He was able to show that the heart may go on beating two or three days after the death of the embryo. The amnion may survive still longer. The retarding influence of chloral hydrate on segmentation, and other facts were noted by the aid of this useful contrivance.

β. Histology.*

Morphology of the Cell.†—Dr. S. M. Lukjanow has studied the intimate structure of the glandular and epithelial cells in the mucous membrane of the stomach of *Salamandra maculata*. His research is accompanied by a prodigal wealth of illustration, forming seven coloured plates.

(1) The cylindrical epithelial cells and the glandular elements inclose a large number of paraplasmic structures which are very similar in the two sorts of cell. One and the same cylindrical epithelial cell may include different kinds of accessory nuclear body, and also mucus spheroids of various kinds. The deep glandular cells show a distinct tendency to produce accessory nuclear bodies and zymogen granules; the more superficial tend to mucinoid metamorphosis, only the cells of the limiting zone can be placed almost without limitation on the same morphological level as epithelial cells.

(2) The extra-nuclear paraplasmic inclosures consist of the same

* This section is limited to papers relating to Cells and Fibres.

† Arch. f. Anat. u. Physiol. (Physiol-Abth.), Suppl. Bd., 1887, pp. 66–90 (7 pls.).

structures as the intra-nuclear, and stand in direct connection with them. They may be stained with eosin and safranin, or with hæmatoxylin. Like the intra-nuclear structures, they may be isolated, or united in complex systems. The following main types may be distinguished:—(*a*) plasmosomata (stained with eosin and safranin); (*b*) karyosomata (stained with hæmatoxylin); (*c*) achromatic granules (forming all sorts of chains, circlets, and aggregates); (*d*) combinations of (*a*) and (*c*); (*e*) combinations of (*b*) and (*c*); (*f*) combinations of (*a*) and (*b*), combinations of (*a*), (*b*), and (*c*); (*h*) combinations of sickles and spheres, rich in eosino- and safranophilous substances, but also plus colourless elements; (*i*) similar combinations, staining dirty violet or deep blue; (*j*) combinations of sickles and spheres with finely granular protoplasmic masses; (*k*) nucleus-like structures containing various forms of the above; (*l*) zymogen granules (stained with eosin and safranin); (*m*) combinations of (*l*) with (*a*); (*n*) combinations of (*l*) with (*c*); (*o*) mucinoid spheroids; (*p*) combinations of (*o*) with (*a*), &c.; (*q*) combinations of (*o*) with (*l*). Surely enough of permutations and combinations! Several may occur both as intra- and extra-nuclear, viz. *a*, *b*, *c*, *d*, *e*, *f*, and *g*. The others are wholly extra-nuclear, though they may be in special indentations of the nucleus.

(3) The above types occur constantly, and must express definite structural relations. The variations are always quantitative, the fundamental structure is constant.

Nuclei of Muscle-cells.* — Dr. S. M. Lukjanow, continuing his contributions to cellular morphology, has investigated the nuclei of unstriped muscle-cells in *Salamandra maculata*.

As regards *form*, the following types of muscle-nuclei have to be distinguished:—(*a*) Regular cylindrical rods rounded at the ends and curved when elongated; (*b*) S-shaped, doubly or trebly curved; (*c*) spirally coiled, with 2, 3, 4, or more twists; (*d*) spindle-shaped; (*e*) like those of cylindrical epithelium, round or oval in optical section. The *size* varies greatly, and is exposed in a series of tables. The *staining properties* are also very diverse even in the same section, and there was no relation between these variations and those of size.

Internal Structure. — The presence of hyaline vesicles or achromatic portions is noted. They form chains within the nuclei. Fine chromatin granules are seen at the poles of contact, and also at times peripherally. The author distinguishes with combined staining the following kinds of nuclear corpuscles:—(*a*) The so-called plasmosomata; (*b*) the so-called karyosomata; (*c*) elements of a mixed character. The various forms and sizes are noted.

Disposition.—The nuclei may (1) lie parallel to one another, or (2) in rows one behind the other. In the chain arrangement, the rows may consist (*a*) of two members of similar appearance; (*b*) of more than two members which are not uniform; and (*c*) of one large rod or spindle-shaped nucleus which bears a much smaller but similar nucleus at one of its poles.

Cell-division.†—Herr F. Tangl has studied the exact connection between the nucleus and the body of the cell during mitosis, and comes to the two following main conclusions:—

(1) With the dissolution of the achromatic nuclear membrane the

* Arch. f. Mikr. Anat., xxx. (1887) pp. 545–58 (2 pls.). † Ibid., pp. 529–45 (1 pl.).

sharp boundary between nucleus and cell-body disappears, until the formation of a new membrane round the daughter-figures.

(2) During the mitosis the connection between cell-body and nucleus is much more intimate than obtains with the resting nucleus. This is probably due to the mixture of "nuclear sap" and the "interfilar mass."

γ. General.*

Aquatic Locomotion.†—M. Amans has made a mechanical study of the modes of aquatic locomotion effected by solid jointed levers. All animals with such apparatus are bilaterally symmetrical ovoids. The mechanical relations of various ovoids are described. He draws a parallel between forms of ovoid and fin, distinguishing on the one hand (*a*) spheres (lower organisms), (*b*) circular ovoids (ciliated echinoderm larvæ), (*c*) elliptical ovoids (vermiform organisms), (*d*) unisymmetrical ovoids (most Vertebrates and Arthropods), and (*e*) asymmetrical ovoids (Pleuronectids, certain Crustacean and Arthropod larvæ). As parallel to these he notes the following forms of fin:—(*a*) embryonic bud, (*b*) circular cone (vibratile cilia), (*c*) bisymmetrical cone, the basilar section of which forms an elongated ellipse (approached by dorsal fin of *Hippocampus*), (*d*) unisymmetrical cone (dorsal, anal, caudal fins), and (*e*) asymmetrical cone (pectorals and abdominals), the base of which forms an oval analogous to the contour of the profile. He distinguishes the various forms of torsion in the appendages, and emphasizes the enormous influence of the resistance of the water on the form both of the body and of its appendages.

B. INVERTEBRATA.

Mollusca.

β. Gastropoda.

Larval Anal Eye in Opisthobranch Gastropods.‡—Prof. H. de Lacaze-Duthiers and M. G. Pruvot report the presence of a remarkable sensory organ in all the embryos of Opisthobranchs which they have examined—*Aplysia*, *Bulla*, *Pleurobranchus*, *Doris*, and others. It is an eye of a size relatively colossal, for it is one-fifth of the total height of the embryo. It has been particularly studied in *Philine aperta*, where a small lobe, destined to form the intestine, is detached on the right side of the endodermal sac, at about the fiftieth hour. At the same time, and just above it, four ectodermal cells, belonging to the ventral surface of the embryo, become slightly raised and begin to be charged with fine pigment-granulations of the brightest carmine colour. They are so arranged as to form a cross with the angle turned upwards; in this cavity a fifth ectodermal cell appears, which will give rise to the crystalline element; it gradually becomes a rich yellow colour, but does not lose its transparency; it is spherical, with a diameter of 15 μ. The four peripheral cells soon encircle it in such a way as to leave at the tip a small pupil, which is elongated transversely. Just by the upper extremity of the eye a small tuft of vibratile cilia make their appearance, and indicate the proximity of the future anus.

Just before the larva escapes, that is, about the sixth day, the anal

* This section is limited to papers which, while relating to Vertebrata, have a direct or indirect bearing on Invertebrata also.

† Comptes Rendus, cv. (1887) pp. 1035–7.

‡ Ibid., pp. 707–10.

eye is completely formed; it is placed in the concavity of the last intestinal loop, and its upper extremity, which carries the pupil, is placed at the level of the anus. The base is less strongly pigmented than the rest, and has on its inner surface a small mass of cells, which are found in section to be insensibly continuous with the ectodermal integument, and which must be considered as the rudiment of the asymmetrical nerve-centre. Longitudinal sections of the organ show that the upper half of the pigmented sac is entirely occupied by the crystalline portion, while its inferior half is lined by a relatively thick layer, which is finely dotted, and evidently represents a retina.

It is clear that this organ presents all the essential parts of a highly specialized eye, and there is no doubt that its duty is to make up for the absence of the cephalic eyes, which are always wanting in the long free larval life which is led by *Philine*.

In *Bulla hydatis* there are two well-developed cephalic eyes, but, nevertheless, the anal eye has the same structure and relations as in *Philine;* but it is interesting to remark that it has no function to perform, for the larva does not become free till the twenty-fifth day, and the eye commences to atrophy before the embryo leaves the egg.

As to the morphological significance of this organ, we are reminded that Prof. Lacaze-Duthiers long since described, at the entrance of the mantle-cavity of aquatic Pulmonates, a "special organ" in the form of a vibratile pit set in a small ganglion; this has always been since regarded as having an olfactory function. As it is always proportionately larger during embryonic life it has been regarded as a larval organ. With this M. Fol has compared the ciliated pads, which have the same innervation and appear to have the same function in Pteropods and Heteropods. It seems to the authors that the anal eye of Opisthobranchs is in them the representative of this structure, the physiological differences in no way implying differences in morphological value.

The otocysts of *Philine* are formed in exactly the same way as the eye, the otolith appearing before the neighbouring cells surround it to form the wall of the auditory vesicle, which only later becomes sunk into the substance of the foot; the pedal ganglion, as is the rule for sense-organs of Gastropods, appears last.

Nervous System of Aplysia.*—Prof. H. de Lacaze-Duthiers continues his morphological study of molluscs, and describes the anatomical nervous relations found in *Aplysia*.

The œsophageal commissure, at the level of the large tentacles and eyes, has this first peculiarity, that the commissure of the pedal ganglia being very long, these two centres become lateral. The two first ganglia of the asymmetrical centre are oblong and small, and situated behind the former.

The brain owes its apparent quadrilateral form to connective tissue, but consists of two rounded ganglia. The external and superior angles give off all the nerves to head and cephalic sense-organs. The inferior external angles give origin to the connectives uniting the brain with the pedals and with the first ganglia of the asymmetrical group. Where the cerebro-pedal connective plunges into the pedal ganglion there arises the very short connective uniting the latter to the asymmetrical ganglion. The cerebral nerves are very closely apposed, the optic is almost always distinct from the tentacular. The latter forms five ganglionic thicken-

* Comptes Rendus, cv. (1887) pp. 978–82.

ings in its organ. The rich innervation of the two buccal lobes is described. Other nerves supply the lips proper.

The pedal centre has really a double commissure. Each ganglion gives off three large nerves below and three above. The largest and most internal of the latter innervates the sensitive region of the foot below the labial palps the other two go to the portion of the foot in front of the head. Of the inferior pedal nerves, the two medians supply the middle region of the foot, the two outer pass outwards to the two large lateral lobes which ascend dorsally, and are sometimes erroneously called the mantle. The intermediate pair innervate the most external portion of these same lobes.

The asymmetric centre.—From the two little ganglia which lie on the pedal centres, and belong to the œsophageal collar, there rises on each side a cord which passes to the neighbourhood of the heart and the base of the gill. There the couple unite in two closely adjacent ganglia. A long closed loop forms with the two superior ganglia the transversal chain of the asymmetric centre.

From the first ganglion on the left, near the pedal of the same side, a nerve descends to where the mantle properly begins, and there divides. The two precardial ganglia give off two large nerves, which are distributed on mantle and viscera. The details of their distribution and the nature of the branchial ganglion are noted. The nerves of the neck arise from the dorsal surface of the pedals.

It is important to notice that mantle, viscera, and gill are supplied as usual by the asymmetric centre, the median ganglia of which are far separated from the collar, and in the cardiac region. They are united by a long connective-like commissure. The mantle-like lobes of the foot are innervated from the pedal ganglia.

Nervous System of Prosobranchs.*—The following are some of the more important general conclusions reached by M. E. L. Bouvier. The nervous system of Prosobranch Mollusca is characterized by a crossed visceral commissure, which is only wanting in the orthoneuroid Azygobranchs. Except, perhaps, in the Docoglossata, there are also two pallial anastomoses; the right anastomosis is related to the right pallial nerve which arises from the pallial ganglion of the same side, and with another right pallial nerve which arises from the subintestinal ganglion, or (when that ganglion is absent) from the subintestinal branch of the visceral commissure. The left anastomosis is established between the left pallial nerve, which arises from the left pallial ganglion, and a branchio-pallial nerve which is given off from the subintestinal commissural branch.

If the right pallial nerve passes by the subintestinal ganglion before passing to its area of distribution, the nervous system is zygoneurous to the right, or there may be zygoneury to the left; in all other cases the nervous system is dialyneurous. Right is much more frequent and important than left zygoneury. We may classify the Prosobranchiata thus:—

(A) Dialyneurous Nervous System: Chiastoneurous Diotocardata; Holostomatous Proboscidifera; the majority of the Rostrifera.

(B) Right Zygoneurous Nervous System: Siphonostomatous Proboscidifera; Stenoglossata; some Rostrifera.

* Ann. Sci. Nat.—Zool., iii. (1887) pp. 1–510 (19 pls.).

(C) Left* Zygoneurous Nervous System: Ampullariidæ, some Crepidulidæ, Naticidæ, Lamellariidæ, Cypræidæ.

(D) False Orthoneurous Nervous System: Helicinidæ and Neritidæ.

Right zygoneury becomes more marked as one ascends the scale of Prosobranchs; the right pallial anastomosis of the Aspidobranchs is at some distance from the right ganglion. In *Paludina*, *Littorina*, and *Cyclostoma*, the two pallial nerves fuse in the walls of the body. Among the Cerithiidæ, Melaniidæ, and Cypræidæ, there are some genera more or less dialyneurous, and others which are more or less distinctly zygoneurous.

Once right zygoneury is realized, the right anterior pallial nerve becomes a connective; this is generally pretty long, but in most of the Stenoglossata it is so short that the subintestinal ganglion becomes intimately connected with the right pallial ganglion.

The nervous system of Diotocardata is essentially characterized by the diffusion of the nervous centres. From the point of view of the nervous system there is no solution of continuity among the different groups which compose the order of Prosobranchs. Thus, in the Tænioglossata the Ianthinidæ and the Ampullariidæ have a very long cerebroid commissure; the Ampullariidæ, Paludinidæ, Cyclophoridæ, &c., have a labial process and a labial commissure, and the Ampullariidæ and the Ianthinidæ very long lateral connectives.

The successive transitions between the Diotocardata and the Monotocardata are more sharply indicated by the ganglionic cords of the foot; the buccal ganglia also undergo progressive modifications as one ascends in the order, for in *Halia* and the Purpuridæ they are closely approximated and almost concentrated into a single mass.

Other modifications are presented by the cerebral commissure, and the maximum of concentration is exhibited by the Stenoglossate Monotocardata, where the buccal ganglia are very close to the cerebral ganglia, and very far from the buccal mass. With these variations there correspond changes in the relations of the buccal connectives.

In the most primitive types the anterior part of the mantle is almost symmetrically and solely innervated by the pallial ganglia. If the right gill and false gill are absent, there is no subintestinal ganglion, and its position in the commissure or in its vicinity is simply indicated by one or two right pallial filaments. As one ascends the Tænioglossata the asymmetrical innervation of the mantle increases in importance, especially on the right side. The Diotocardata are the least asymmetrical of all the Prosobranchs.

After describing the innervation of the gills, and the characters of the visceral ganglia, the author proceeds to consider the otocysts; these may be divided into three groups; (1) Otocysts with numerous otoliths as in Diotocardata and some Rostrifera; (2) Otocysts with numerous otoliths inclosing a large round otolith, as in *Turritella rosea;* and (3) Otocysts inclosing a single otolith, as in remaining Prosobranchs. Although it would be an error to deny all systematic value to the otocysts, the author thinks that their importance, from this point of view, has been over-estimated.

The penis is not always, as has been stated, a cephalic formation innervated from the cerebral ganglion, for four kinds may be distinguished.

* In the text B and C are both "Système nerveux zygoneure à droite."

A pedal penis, as in most Tænioglossata and Stenoglossata; a cephalic penis, as in Neritidæ, Paludinidæ, and Calyptræidæ; a dorsal penis, innervated from the subintestinal ganglia as in the Cyclostomidæ and *Bythinia*; and a pallial penis, as in the Ampullariidæ. With the exception of the Neritidæ all the Diotocardata hitherto examined have been found to be without a penis.

Among the Pulmonates the torsion of the body displaces the organs or modifies the asymmetry of the nervous system; but among the Prosobranchs it is not so; for the dextral Ampullariidæ have the anus, the penis, the gill, and the rectum to the right, and the siphon and the false gill to the left; it is exactly the same in the sinistral forms, and they have the nervous system twisted in just the same way as that of the dextral forms. In the Prosobranchs, then, the torsion of the body does not displace the organs or modify the asymmetry of the nervous system. We must, therefore, reject all the hypotheses which explain the torsion of the nervous system by that of the body.

In Prosobranchs the presence of a lung is no indication of a relationship between pulmonate forms; the Cyclophori, which are always placed near the Cyclostomata, are much closer to *Turbo* or *Delphinula*.

After indicating the various modifications undergone by different parts of the digestive system, M. Bouvier points out that the Prosobranchs, which have become adapted to a special mode of life, have, as a rule, undergone profound and apparently abnormal changes in their organization; in their progressive evolution the members of the group have gone through three chief stages. The nervous system was at first dialyneurous, diffused, and provided in the foot with ganglionated scalariform nerve-cords; the gill was bipectinate; the heart, with two auricles and a ventricle, was traversed by the rectum; the very well developed buccal mass was situated behind the nerve-collars; the salivary glands were applied to the buccal mass, and their ducts did not traverse the nerve-collars; there was no siphon, or penis, and the renal organ opened by a tube into the pallial cavity. In the second stage the nervous system was dialyneurous or zygoneurous, and more or less concentrated; there were no scalariform cords in the foot; the gill was monopectinate, and a false gill more or less developed; the heart had but one auricle, and the ventricle was not traversed by the rectum; the buccal mass moderately developed, and situated in front of the nerve-collars; the salivary glands were separated from the buccal mass, and the ducts traversed the nerve-collars; a penis was generally present, the renal organ opened by a cleft at the base of the pallial cavity; the otocyst had one or more otoliths, and the buccal ganglia were applied against the buccal mass. The characters of the third stage are a zygoneurous, highly concentrated nervous system, no scalariform pedal cords; gill monopectinate, well developed, bipectinate false gill; heart with one auricle and untraversed ventricle; poorly developed buccal mass, from which the salivary glands—whose ducts traverse the nerve-cords—are separated; buccal connective very short, but deep; siphon, penis, proboscis, unpaired special gland; renal organ opening by a cleft at the base of the pallial cavity; a single otolith in the otocysts.

These characters appear to be sufficient to justify the establishment of three great divisions of the Prosobranchiate Gastropods, the Diotocardata, tænioglossate Monotocardata, and stenoglossate Monotocardata; and this mode of classification is supported by the facts of palæontology,

for the first division had a number of representatives in palæozoic times, the second was abundant in secondary epochs, and the Stenoglossata are common in tertiary strata. The author appends a somewhat detailed table of affinities and classification.

Development of Helix Waltoni.*—Drs. P. and F. Sarasin found that *Helix Waltoni* is very abundant in Ceylon. The young are remarkable for the long time that they remain in the egg, where two larval organs—caudal vesicle and primitive kidney—develope to a considerable size. The former is finally as much as 1½ cm. long; it is, doubtless, as Gegenbaur has suggested, the embryonic respiratory organ. The primitive kidney is large enough to be seen, on dissection, with the naked eye, and has the function of an embryonic renal organ.

On some parts of the body-epithelium small bud-like structures, which are found to be sensory, may be seen; they consist of a small number of large pyriform sensory cells with stiff processes, and are inclosed by long supporting cells. The whole structure calls to mind the lateral organs of Amphibia. The lateral organs found by Haller in rhipidoglossate molluscs appear to be more diffuse; the lateral organs of *Helix* are regarded as larval organs.

The rudiments of the central nervous system are laid down very early; before the tentacles are visible the cerebral ganglia appear as rounded masses of cells, still connected with a well-marked thickening of the epithelium of the sensory plates. When the cerebral mass is well developed there appear on either side of the sensory plates two invaginations, which grow out into long tubes with cæcal widened ends; these the authors call the cerebral tubes. Later on a large lobe may be seen on either side of the cerebral mass; these, which have a different structure from the brain, may be called the accessory lobes; the spaces in them are nothing else than the cavities of the two cæcal sacs of the cerebral tubes; later on the two spaces and the efferent duct disappear. These observations will doubtless explain the discrepancies in different accounts of the development of the brain of Mollusca; the authors who state that the brain is formed from an epithelial thickening have probably examined early stages, while those who have described it as arising by invagination have seen the later.

The authors believe that these cerebral tubes are the homologues of the olfactory organs of Annelids, described by Kleinenberg in *Lopadorhynchus;* in Molluscs they do not permanently retain the character of open tubes, but pass into the brain, of which they form the lobes.

Morphology of the Heteropod Foot.†—Prof. C. Grobben gives a critical account of the views of Huxley, Gegenbaur, Leuckart, Ray Lankester, and others on this subject; but brings forward nothing which can be called new. The investigation shows that in connection with the pelagic life, and the associated development of a swimming-lobe upon the foot, the primitive Gasteropod sole has degenerated into a sucker-like structure, which in the Pterotracheidæ forms a secondary sex character through its absence in the female. With the shortening of the foot-sole is connected the specialization of the portion bearing the operculum, which forms the tail-like posterior part of the body, and whose fin-like development is in relation to the pelagic life of the Heteropoda.

* Zool. Anzeig., x. (1887) pp. 599–602.

† Arbeit. Zool. Inst. Univ. Wien, vii. (1887) pp. 221–32 (1 fig.).

γ. Pteropoda.

Nervous System of Pteropods.*—Dr. P. Pelseneer has studied the nervous system of Pteropods, in regard to which a certain degree of vagueness has hitherto existed,

(1) In *Gymnosomatous* Pteropods, the central nervous system, compared with that of thecosomatous types, is characterized by the position of the cerebral ganglia, which are apposed one upon the other, and situated on the superior surface of the œsophagus. (2) In all genera except *Halopsyche* the pleural ganglia are paired, and not unpaired as Von Ihering has maintained. Each pleural ganglion gives origin to a nerve which anastomoses with a pedal (lateral cervical) nerve. All the Gymnosomata exhibit a double pedal commissure. (3) The buccal appendages of *Clione* and *Pneumodermon* are innervated by the cerebral ganglia, and not by the pedals as Gegenbaur stated. These appendages are therefore not pedal in their nature. (4) The visceral commissure of typical Gymnosomata exhibits two superposed ganglionic masses, which give origin to the asymmetrical nerves, three from the left, and one from the right, and not to symmetrical branches as most authorities describe them.

As to *Thecosomatous* Pteropods, the central nervous system has been often described. Pelseneer contents himself for the most part with emphasizing that the system is characterized (1) by the separation of the cerebral ganglia, which are situated on the sides of the œsophagus, and united by a long supra-œsophageal commissure, (2) by the absence of pleural ganglia, the pedals and viscerals being directly apposed to the cerebrals from which they are separated only by a constriction, and (3) by the coalescence of all the ganglionic elements of the visceral commissure in a single elongated mass. The nerves which spring from the visceral ganglion are in origin asymmetrical. The left portion of the ganglion gives origin to three principal nerves, the left pallial and two viscerals, while the right portion only gives rise to the right pallial. Souleyet alone has given a correct representation of this fact. The nervous system of *Cymbulia* is discussed in detail. *Halopsyche* among Gymnosomata agrees with *Cymbulia*. Three types may be distinguished: one represented by the two genera just named, a typical Gymnosomatous, and a typical Thecosomatous arrangement.

The author then discusses the homologies between the various Pteropod types, and between these and molluscs generally. (1) The two lateral ganglia—right and left—of *Halopsyche* and *Cymbulia* are homologous with the anterior or pallial visceral ganglia of other molluscs, for they give origin to nerves which supply similar regions. The unpaired median ganglion of the same genera corresponds to the united posterior visceral ganglia of other molluscs, for they give rise to nerves which supply the circulatory, respiratory, and reproductive apparatus. (2) The left ganglion of typical Gymnosomatous Pteropods is homologous with the left anterior visceral, and posterior visceral together, while the right ganglion of the former corresponds to the right anterior visceral. (3) The left portion of the visceral ganglion of typical Thecosomata is homologous with the left anterior visceral and posterior visceral together, while the right half corresponds to the anterior right visceral. The visceral ganglionic mass of typical

* Arch. de Biol., vii. (1887) pp. 93–129 (1 pl.).

Thecosomata thus corresponds to the sum of the four ganglia of the visceral commissure.

In general, (*a*) the pleural ganglia are paired in Gymnosomata as in all molluscs where they are present; (*b*) the buccal appendages of Gymnosomata are innervated by cerebral ganglia, and cannot therefore be compared with Cephalopod arms; (*c*) the Pteropods are thus separated from Cephalopods. The asymmetry of their visceral commissure separates them from all molluscs with symmetrical visceral commissure. They approach the Gasteropods, and especially, as Spengel noted, the Euthyneura.

'Challenger' Pteropoda (Gymnosomata).*—Dr. P. Pelseneer has published the first part of his report on the Pteropoda collected by H.M.S. 'Challenger,' which has become a critical account of all known genera and species. The adult Gymnosomata are characterized by the absence of a mantle-skirt, pallial cavity, and shell; by the presence of a well-developed head, bearing two pairs of tentacles, of which the two posterior bear rudimentary eyes; by two fins of which the anterior edges are not joined together backwards, above the mouth; and by the anus being situated at the right side of the body. They are carnivorous, and often feed on their thecosomatous allies. Eleven species were collected by the 'Challenger,' four of which are new; all the known twenty-one forms are discussed in the systematic portion of this memoir.

δ. Lamellibranchiata.

Photogenic Property of Pholas dactylus.†—M. R. Dubois has made a series of experiments which show that the photogenic property of *Pholas dactylus* is independent of any organ, and is a chemical phenomenon. From the luminous parts of the animal the author has succeeded in extracting two substances, the contact of which, in the presence of water, determines the appearance of the light. One of them was obtained in the crystalline state, and possesses the special optic properties which give to photogenic tissues their opalescence. It is soluble in water, and hardly soluble in alcohol; it may be called luciferine. The other body is an active albuminoid of the class of soluble ferments, and may be called luciferase. These two substances are necessary to, and sufficient for the production *in vitro* of the phenomena of animal luminosity, improperly called phosphorescence. The results here obtained confirm and generalize those attained to by the author after his study of the luminous Elateridæ.

Molluscoida.

a. Tunicata.

Central Nervous System.‡—M. F. Lahille has studied the development of the central nervous system in a large number of Tunicate embryos, and comes to the following conclusions. The typical central system consists of a median tube of epiblastic origin, with bilateral symmetry, and with numerous ganglionic masses. If the principal masses are considered as forming so many ganglia, the following may be distinguished: (1) the anterior (tactile); (2) the sensory (ocular and

* Reports of the Voyage of H.M.S. 'Challenger,' lviii. (1887) 72 pp. and 3 pls.
† Comptes Rendus, cv. (1887) pp. 690–2. ‡ Ibid., pp. 957–60.

auditory); (3) the cerebral; (4) the posterior (branchial); (5) the visceral; and (6) the caudal. The brain of the adult Tunicate arises from the union of the first ganglia. As to the segmentation of the nervous system in Tunicates, it is a matter of appreciation.

β. Polyzoa.

Spermatogenesis.*—M. A. de Korotneff finds in *Alcyonella fongosa* a very fit object in which to study the process of spermatogenesis. The succession may be summed up in La Valette St. George's familiar formula, spermatogonia give rise to spermatocytes, these become spermatides and mature into spermatozoa.

The young endodermic cells of the funiculus of a bud have spherical transparent nuclei. These contain nucleoli and these alveoli. The nuclei of these spermatogonia multiply without trace of karyokinesis. Multinuclear cells result, the nuclei being situated just below the cellular membrane. The individual spermatocytes bud off spermatides, and the whole mass comes to have the appearance of a transparent vesicle covered superficially by a thick layer of maturing sperms.

The external surface of the peripheral (outer) end of each nucleus is surrounded by a homogeneous sheath, which gives off a process forming the central filament of the tail. The internal surface of the nucleus has a gradually thickening cap of protoplasm. The first-mentioned sheath acquires a swollen vase-like form, and after certain modifications becomes the neck of the spermatozoon. The internal cap separates from the nucleus, and becomes gradually conical. The nucleolus, a small well-defined spherule, becomes finally lodged in this cap, where it is protected, and forms the essential part of the head. The details are minutely described.

M. Korotneff suggests, in regard to the peculiar sperm of *Ascaris megalocephala*, that the caudal portion is the head-cap, and its nucleus really the nucleolus. The other portion contains a number of filaments plunged in a protoplasmic mass; these structures may be identified with the tails of other spermatozoa, and compared, for instance, with the processes seen in the crayfish sperm.

Fresh-water Bryozoa.†—Herr M. Verworn has investigated the structure and development of *Cristatella*. He finds that the chief anatomical peculiarities are the presence of a movable pedal disc on which the individuals are arranged in parallel rows, the complete absence of an ectocyst and of a fold of the endocyst; as a consequence the anterior and posterior parieto-vaginal muscles have disappeared; there are a comparatively large number of tentacles.

The author adopts provisionally the view of Kräpelin that the whole outer cell-layer of the integument is formed by ectoderm, the inner lining of the body-cavities by mesoderm, and the inner epithelium of the enteric tract by endoderm; embryological investigations are, however, needed on these points. The pedal disc consists of an outer ectodermal layer, a median muscular layer, and a mesodermal pavement epithelium. The first of these has, in addition to large vesicular cells and others containing a clear slimy mass, long cylindrical glandular cells with a broad base on the lower surface and at the sides; between

* Comptes Rendus, cv. (1887) pp. 953–5.

† Zeitschr. f. Wiss. Zool., xlvi. (1887) pp. 99–130 (2 pls.).

these there are pores by which the mucous secretion passes to the exterior. The cylindrical cells have an important function in the movement of the colony, as they secrete a thin transparent and chitinous membrane, which affords a smooth surface which lessens friction and affords a strong fulcrum. The musculature of the foot consists of a longitudinal and a transverse layer, the fibres of which are set at right angles to one another. The cells of the mesodermal epithelial layer are provided with very short cilia which can be easily missed, and which the author only saw with certainty in living specimens. The septa which traverse the cavity of the pedal disc are completely formed of mesoderm; they are made up of a hyaline supporting membrane on either side of which are longitudinal fibres and pavement epithelium; their layer of transverse fibres is feebly developed or completely wanting.

The integument of the separate individuals is the direct continuation of the upper covering of the disc, and consequently consists of the same three layers as compose it; although there are, of course, certain differences in the details. The walls of the lophophore and of the tentacular crown are formed of the same layers as the cystid. The tentacles are to be regarded as evaginations of the cavity of the lophophore, which, again, communicates with the body-cavity.

The enteric tract is made up of the endodermal enteric epithelium, a median muscular layer, and an outer mesodermal cœlomic epithelium. The epistome carries externally a layer of ciliated cells, which are highest near its base. The foregut is divisible into two parts, which are histologically quite distinct. The lining epithelium of the pharynx is the direct continuation of the ciliated investment of the epistome, and presents very long, delicate, ciliated cells, separated from one another, like those of the epistome, by clefts. About the middle of the foregut the ciliated cells suddenly cease, and the epithelium of the œsophagus commences. Its cells are long, delicate, and cylindrical, but they have no cilia, and do not stain like those of the pharynx; nor are they separated from one another by clefts. Inferiorly, the foregut is bounded by a circular valve, which at its margin takes on the characters of the epithelium of the stomach. As in *Alcyonella*, the stellate form of a transverse section of the lumen of the stomach is due to the fact that the cells which form the longitudinal ridges of its wall are knobbed at their free ends and greatly elongated, while the intermediate cells have sharper tips and are comparatively short. It will be observed that there is no formation of true folds, but it is of greater interest to note that the cells and the ridges are histologically and physiologically different from those which are found in the intermediate grooves. The former have generally one or two thin transverse walls which appear to be formed by hardened secreted surfaces; the grey finely granular contents at the knobbed end are much darker than those of the rest of the cell, and often, indeed, the upper cell-boundary is quite broken through by the finely granular secretion which passes freely into the stomach. The secretion of the ridge-cells does not stain, while those of the groove-cells always take a dark colour throughout their whole extent; that of the former is a slimy mass which envelopes the particles of the food and connects them with one another.

The rectum is sharply distinguished from the stomach; the contour of its lumen is round, and its lining cells low and broad.

The mechanism of digestion has been observed in living specimens

by the aid of the horizontal Microscope. Diatoms and desmids are caught by the currents set up by the cilia of the tentacular crown, and passed into the foregut, at the base of which they lie until a quantity of them have been collected. By a wave-like constriction of the foregut they are then passed through the circular valve into the stomach. By the peristaltic action of the stomach the food is driven backwards and forwards; the food is next impregnated with the enteric secretions, and then begins to be absorbed. A fresh quantity of food again enters from the œsophagus, and the indigestible portions of the first mass are driven into the rectum. With regard to the reproductive apparatus, the author is confident that the funiculus is formed solely by the mesoderm.

Little can be added to Nitsche's account of the nervous system; osmic acid preparations showed that the cells composing the ganglion have rather large nuclei, and especially those that are central. The ganglion is invested by a thin mesodermal layer, by means of which it is attached to the upper part of the pharynx; as there is no mesodermal layer between the pharynx and ganglion, the latter appears to be constricted off from the pharyngeal wall. With regard to a colonial nervous system, the author remarks that it may be thought that if ever it be present in a fresh-water Bryozoon it must be found in *Cristatella*, but he has convinced himself that the creeping movements are effected in a way which makes such a system superfluous. They are the resultants of the pressures exerted by the separate animals on the pedal disc, and their direction is caused by the direction of the separate animals.

Herr Verworn has investigated the development of the statoblasts, and finds that at a definite point of the funiculus the epithelial cells increase, and form a small swelling, which presses on the lumen; one cell now passes into the lumen and becomes an egg-cell, while the others form a follicle; the egg goes through a regular process of cleavage, the final result of which is a solid morula; it is clear from this that the statoblasts have not the nature of buds, and it may be said that the statoblasts are parthenogenetic winter ova which, unlike the fertilized ova, are developed on the funiculus.

Arthropoda.

Primitive Insects.*—Prof. B. Grassi continues his researches on the ancestors of Myriopods and Insects. He calls attention at the outset to an overlooked memoir by Meinert, which describes the genital organs of *Machilis*. Grassi's present memoir begins with a classification of Thysanura, which includes the four families Campodeadæ, Japygidæ, Machilidæ, Lepismidæ. The latter comprise three genera, *Nicoletia*, *Lepismina*, *Lepisma*. The characters of the family and of the three genera are given in detail. He then proceeds to give a useful summary statement of the characteristics of the species.

The next chapter is devoted to an account of the anatomy of *Lepisma* and *Lepismina*, which he compares with his previous results, gained from the investigation of *Machilis* and other forms.

Prof. Grassi next discusses the musculature of Thysanura, seeking to discover whether the Thysanura once had wings or not, and whether there are any traces of the previous existence of abdominal appendages. He finds in the musculature no evidence whatever to warrant the first of

* Bull. Soc. Entomol. Ital., xix. (1887) pp. 52–74.

these suppositions. In the musculature of the pseudo-appendages some traces of the musculature of lost true abdominal appendages may probably be detected. It is not possible to make any direct comparison between the musculature of Thysanura and that of Annelids or of *Peripatus*.

α. Insecta.

Love-lights of Luciola.*—Prof. C. Emery has given a most entertaining account of his observations on the love-lights of *Luciola*, which he studies in the meadows round Bologna. By catching females and imprisoning them in glass tubes in the meadows he satisfied himself that sight, not smell, was all important. When the females caught sight of the flashes of an approaching male then they allowed their splendour to shine. The dance of the male round the female, the gathering crowd of rivals, the insatiable desires of the female attracting one lover after another, the accomplishment of fertilization, are all most beautifully and graphically described. In the two sexes the colour of the light is identical; the intensity appears much the same, but that of the female is more restricted. The most noteworthy difference lies in the fact that the rhythm of the male is more rapid and the flashes briefer, while that of the female is longer, more distant, and more tremulous. Besides undoubtedly serving for purposes of attraction, the light appears to be utilized for illuminating the path, especially if there be obstacles in the way.

Mimicry and Parasitism of Camponotus lateralis.†—Prof. C. Emery has made some observations on the mode of life of one of the more common ants of the Mediterranean fauna—*Camponotus lateralis*. Two forms occur in Italy, one red, the other quite black (*C. foveolatus* Mayr, *ebeninus* Em.) The black variety, with only the prothorax red (*C. dalmaticus* Nyl.), is very rare, and seems to be represented only by isolated forms. The red and black worker ants of *C. lateralis* are so like *Cremastogaster* that an inexpert eye would not distinguish them. The two forms seem to live on friendly terms. In the same way the black variety is related to other black ants, such as *Formica gagates*. Prof. Emery was inclined to suppose that *C. lateralis* might utilize its colour-likeness to other ants by associating itself with them so as to have the benefit of their guidance to food-supplies. But he thinks that the imperfect vision of ants makes such a supposition improbable. He is of opinion that the red and black form of *C. lateralis* finds an advantage in being like its companion *Cremastogaster* for the usual reason, that it thereby escapes from some enemy which mistakes it for *Cremastogaster*, whose taste the myrmecophagous enemy is supposed to dislike. More observations are obviously necessary.

In regard to the habit of *C. lateralis*, Prof. Emery records an interesting case where he found a society living parasitically on a beehive. They appeared to him to feed on spoils of honey from the combs.

Sand-wasps.‡—Herr A. Handlirsch publishes a monograph on the forms of Sphegidæ related to *Nysson* and *Bembex*. The memoir is of purely systematic interest. It includes a bibliography of 15 pages, and is accompanied by 5 plates. Sixty-four species of *Nysson*, a few of them new, are described.

* Bull. Soc. Entomol. Ital., xviii. (1887) pp. 406–11. † Ibid. (1886–7) pp. 412–3.
‡ SB. Akad. Wiss. Wien, xcv. (1887) pp. 246–420 (5 pls.).

Thermic Experiments on Periplaneta orientalis.*—Prof. V. Graber describes a long series of experiments conducted with a view to determining the sensibility of the cockroach to heat. A tin chamber whose ends were kept at different temperatures by water-baths was the apparatus, and the results obtained are briefly as follows:—The animals lost power of locomotion at 11–12° C., and death resulted at 5–6° C. (vital minimum). Life, again, was barely sustained with the air at 37° and the floor of the chamber at 39°, a temperature of 41–42° producing death. Other experiments proved the creatures to have a decided liking for situations where the floor temperature nearly resembled the air temperature, and a bad conductor of heat was much preferred as a resting-place to a good one. The optimum temperature seemed to be between 25° and 29° C., though some experiments contradicted this; and a series of observations in which the animals were allowed a choice between extreme temperatures seemed to show only that they preferred heat to cold, unless the heat was too excessive.

Diminution in Weight of Chrysalis.†—Herr F. Urech has studied the quantitative relations of metabolism in the chrysalis of *Pontia brassicæ*. He finds that the weight of the chrysalis continually decreases. At a constant temperature, the weight steadily decreases, but the decrease becomes finally more rapid, especially some days before liberation. If the temperature be slightly raised the period of chrysalis diminishes. Dry air also shortens it.

Eyes of Diptera.‡—Professor G. V. Ciaccio has published a series of twelve double plates illustrating the histology of the eyes of Diptera. This iconographic work includes one hundred and seventy-three figures, each family is figured by itself, with a representation first of the entire organ, and then of the component parts. It is to be regretted that the health and engagements of the author did not permit of the addition of a descriptive text. Full explanations, however, accompany each plate.

Bacteria-like Bodies in Tissues and Ova. §—Herr J. Blochmann has studied the occurrence of bacteria-like bodies in the tissues and eggs of various insects, e.g. in *Periplaneta orientalis* and *Blatta germanica*. In the central cells of the fatty body, in the ova, and in the embryos these curious elements were abundantly found. They occur in other animals besides insects, and closely resemble the bacteroids noted in the roots of Leguminosæ. Leuckart observed similar bodies, which he was inclined to regard as parasitic, under the cuticle of *Distomum cercariæ*. Schneider observed similar structures in *Mesostomum*. F. E. Schulze suggested that similar structures in *Pelomyxa* were symbiotic Bacteria, or perhaps reserve accumulations. Korschelt noted the appearance of small strongly refractive granules in the yolk-grains of bug ova. Zacharias and Van Beneden have observed similar elements in the ova of *Ascaris megalocephala*. They grow and divide, and are to be regarded as primitive granules. Altmann has also described their physio-chemical import.

* Arch. f. d. Gesammt. Physiol. (Pflüger), xli. (1887) pp. 240–56.
† Arch. Sci. Phys. et Nat., xviii. (1887) pp. 433–6.
‡ Mem. Acad. Sci. Bologna, vi. (1885) pp. 45–72 (12 pls.).
§ Biol. Centralbl., vii. (1887) pp. 606–8. Versamml. Deutsch. Naturf. u. Aerzte, Wiesbaden, 1887.

Fauna of the Tombs.*—M. P. Mégnin has shown that the popular notions that corpses formed the food of worms, and the less vulgar one that they crumbled to dust under chemical and physical agencies, are both erroneous. He has studied the fauna of the tombs, having had opportunity for this gruesome task in connection with sanitary inquiry. Corpses are devoured by insects which attack them at various and definite periods of decomposition, so definite indeed that from the insects on the corpse the date of burial could be proved to a medico-legal investigation. Some of the insects were larval, others chrysalids, others adult.

The list is as follows:—Four species of Diptera: *Calliphora vomitoria*, *Curtonevra stabulans*, *Phoras aterrima*, and an undetermined *Anthomyia*; one species of Coleoptera, *Rhizophagus parallelocollis;* two Thysanura, *Achorutes armatus* and *Templetonia nitida;* and lastly a young undetermined *Iulus*. These occur in definite succession on the body.

How do these insects get down to a depth of two metres, and through well-jointed boards? Dampness and pressure cause the latter to give way, and paths of penetration are readily formed. The larvæ of *Calliphora* and *Curtonevra* were found only on bodies which had been buried in summer, and must have been deposited on the dead before inhumation. The larvæ of *Phoras* and *Rhizophagus* must be supposed to penetrate the whole stratum of earth. *Phoras* is specially found on thin bodies, *Rhizophagus* on the reverse.

Rhizophagus parallelocollis is a rare insect, its larva has not before been known. No wonder. "Besides revealing these facts extremely interesting from a biological point of view, this research had contributed some entomological material of use in legal medicine."

β. Myriopoda.

Powers of Vision.†—M. F. Plateau contributes an historical summary of past researches on the structure and function of simple eyes, and gives an account of his observations as to the vision of Myriopods.

A very simple and lucid account is given of the general structure of a simple eye. This is accompanied by a few diagrammatic figures. The second portion of the memoir is devoted to a summary of the various opinions held in regard to the function of simple eyes, and especially of those of Dujardin, Exner, Grenacher, and Patten.

The author then gives a detailed account of his experiments on numerous Myriopods, and summarizes his results. (1) Myriopods distinguish light from darkness; (2) as this power is exhibited by normally blind forms, the perception of light in forms with eyes may be partially due to dermatoptic sensations; (3) Myriopods see very badly, and supplement their insufficient sight by touch, which is principally localized in the antennæ; (4) species with eyes are not much better situated than those which are blind; (5) forms with eyes perceive at a distance an object placed in their path only when it reflects much white light, or light belonging to the most refrangible region of the spectrum; this perception is probably in part dermatoptic; (6) Myriopods do not distinguish the forms of objects; (7) but some of them can

* Comptes Rendus, cv. (1887) pp. 948–51.
† Bull. Acad. R. Sci. Belg., xiv. (1887) pp. 407-48 (1 pl.).

perceive big movements. Theoretical conclusions must be carefully corrected by experiment. The imperfection of visual sensation in some, and the total absence of eyes in others, must be considered in association with their mode of life.

γ. Prototracheata.

Development of Peripatus Novæ-Zealandiæ.*—Miss L. Sheldon commences by explaining that the want of completeness in her account of the development of the New Zealand species of *Peripatus* is due to the necessity of killing the gravid parents as soon as they reach England. The ripe ovum of this species is large as compared with that of *P. capensis* or *P. edwardsii*, the length of 1·5 mm. being due to the amount of food-yolk with which the egg is charged. There is a thick tough shell, and a thin and membranous vitelline membrane. The nucleus of the egg before segmentation varies somewhat in position; it may have a peculiar lobed form, and consist of three masses of deeply staining material, between which is a portion of nuclear substance which stains less deeply. The segmentation is like that of some other Arthropods, and agrees with the mode lately described by Henking in certain Phalangidæ in the irregular arrangement, in young stages, of the nuclei of the blastoderm; but Miss Sheldon does not consider each yolk-segment as a single cell, for she found no relation between the yolk and the nuclei. What differences obtained between eggs of the New Zealand and Cape species are probably due to the presence of yolk in the former; in neither are there any cell-outlines, the protoplasm of both forming a perfectly continuous reticulum in which the nuclei are imbedded. As to the mode of development it might be said that the embryo is "formed by a process of crystallizing out *in situ* from a mass of yolk, among which is a protoplasmic reticulum containing nuclei."

The embryo obtains its nutrition from the yolk contained within its body, and from a peripheral layer of yolk in which are imbedded numerous small, round, highly refractive bodies. This latter is a very remarkable and unusual mode of embryonic nutrition, but its object is evidently to supply the ectoderm with a constant source of nourishment. A somewhat comparable arrangement has been described by Ganin in *Platygaster*, and a somewhat similar result is brought about, though by different means, in those insects which undergo an internal development, and in which the embryo is completely imbedded in the yolk; the process in *P. Novæ-Zealandiæ* is simpler, for nothing corresponding to the amnion is present. It is, at any rate, clear that there are in Arthropods various modes for the protection of the embryo and the nutrition of the ectoderm, and that, though these differ very largely in their mode of origin and structure, they resemble one another in their physiological functions.

The segmentation is on the centro-lecithal type; the protoplasm is mainly at one pole of the egg, and in it nuclei arise, probably by the division of the original segmentation nucleus. In the latest stage observed the loose protoplasmic reticulum covered above half the periphery of the egg. In the course of development the protoplasmic area becomes more compact and flattens out, forming a plate-like mass densely packed with nuclei; at this time the embryo is a closed sac, the

* Quart. Journ. Micr. Sci., xxviii. (1887) pp. 205-38 (4 pls.).

walls of which are separated from the vitelline membrane by a thick layer of yolk; it is inclosed in a thin layer of protoplasm with nuclei which represents the ectoderm. Along one line there is a prominent ridge on the outer side of the ectoderm, composed of proliferating nuclei; anteriorly this ridge divides into two, which remain attached to one another above and below, and so inclose a cavity between them. The præoral lobes next appear; not far from the anterior end of the embryo the yolk is divided by a protoplasmic septum, which divides the body of the embryo into two sacs, one lying above the other; posteriorly these two sacs communicate. By the ingrowth of the surrounding tissue the septum becomes divided into two layers, and the embryo now consists of a sac doubled on itself in such a way that the ventral face of the anterior part of the body is opposed to that of the posterior part. The embryo next begins to straighten itself out; in the anterior region the somites are represented by a series of definite cavities at the side of the body, and, later on, they appear throughout the whole length of the embryo. When the peripheral food-material has been completely absorbed the embryo lies just within the vitelline membrane and egg-shell. Along a lateral ridge the appendages begin to appear as blunt rounded protuberances; the antennæ arise as buds on the præoral lobes. The nerve-cords first arise as special rounded elements at the internal ventral angles of thickenings of the ectoderm over the leg-ridges.

δ. Arachnida.

Acarida on Trees.*—Herr C. W. S. Aurivillius was prompted by the researches of Dr. Lundström on "domatia" (see *infra*, p. 87) to investigate the nature and behaviour of some of the Acarid guests which abound on the leaves of trees. He describes in detail the structure and mode of life of three forms—*Tydeus foliorum*, *Gamasus vepallidus*, and a third, found as nymph and larva, and apparently an Oribatid, very like *Cepheus tegeocranus*. All the three were found on leaves of *Tilia*. From observation, and from a study of their mouth-parts, the author was convinced that these guests could not derive their food from sucking wounds which they might not unnaturally be supposed to make on the leaves, nor did *Tydeus* appear to attack the Aphides. They more probably live on small solid particles, not due to their own exertions, but such for instance as fungoid spores.

ε. Crustacea.

Development of the Compound Eye of Crangon.†—Dr. J. S. Kingsley, who has already published a preliminary notice on this subject,‡ now gives full details as to his observations on the development of the compound eye of *Crangon*.

The compound eyes begin to make their appearance soon after the closure of the blastopore: there is a shallow pit, which rapidly grows deeper, and, extending outwards, downwards, and forwards, soon comes to occupy a position beneath the anterior and outer part of the optic disc before any striking changes are visible in the external appearance of the embryo. The separation of the pit from the epiblast is completed at about the time of budding of the first pair of appendages, and the

* Nova Acta Soc. Sci. Upsala, xiii. (1887) pp. 1–16.
† Journ. of Morphology, i. (1887) pp. 49–64 (1 pl.).
‡ See this Journal, 1887, p. 84.

appearance of the stomodœum. There are now three layers, all of which are concerned in the development of the optic apparatus; the outermost is the epiblast, and the two others are derived from the invaginated portion of the same layer. The innermost may be called the gangliogen, as it will give rise to the chain of ganglia and nerves which lies within the stalk of the adult eye, and connects the optic apparatus with the brain. The middle layer—which may be called the retinogen—will give rise to all the retinal parts of the eye.

Some complex changes in the appearance of the cells are brought about by the mode of division of their nuclei; after a time it will be found that the ectodermal nuclei has come to correspond with those of the underlying layer, and that the nuclei of the retinogen and gangliogen have each given rise to five nuclei arranged in a row, while the rows are arranged in sets. In section two will be seen closely appressed to each other, and separated from the adjacent parts by a rod of apparently structureless material; this last is the rudiment of the crystalline cone, and the adjacent rows of nuclei belong to different ommatidia, or optic elements. In the ganglionic layer the rows of nuclei have broken, and formed the rudiments of two ganglia.

In a later stage the epidermis-cells will be seen to be distinct from those of the retinogen and to have become the cuticle, which is modified into lenses over each crystalline cone. Development and differentiation have gone on in the rows of retinal nuclei, each of the cells having become greatly elongated, the protoplasm extending out to a considerable distance from the nucleus in a thread-like prolongation; the nuclei are placed at different heights in those cells, and the tail-like prolongations are arranged in layers around the crystalline cone; the distal cell of the retinal row is clearly the crystalline cone-cell or retinophora. Four of these surround the cone, and their walls so touch that they form a cup in which the cone is situated, and from which it is secreted. Below the calyx the ends of the retinophoral cells unite to form a slender pedicle, which is clearly the rhabdom of Grenacher, and which is, as clearly, formed by the retinophoræ, and is not a secretion from the surrounding pigment-cells.

As to the phylogeny of the Arthropod eye, we may suppose that the invaginated pit had sensory functions, and either wall must, for a time, have been like its fellow, as is shown by its having similar nuclei, and by the similar development of rows of nuclei. The position of the eye at the extreme ends of the nervous cords would indicate that it was differentiated as part of the primitive nervous system; but it is not yet to be said that the invagination was confined to the eye alone, and did not extend through the whole length of the cords; on this question the fact that the supra-œsophageal commissure developes much later than the optic cords may be of significance.

'Challenger' Cumacea.*—Prof. G. O. Sars commences his account of the Cumacea collected by H.M.S. 'Challenger,' by considering their morphology. He cannot agree with Boas in regarding them as very nearly related to the Mysidæ, but thinks they represent an isolated branch, which cannot strictly be derived from any of the recent groups; it is possible that some of the palæozoic Phyllocarids formed a direct transition to the Cumacean type.

* Reports of the Voyage of H.M.S. 'Challenger,' lv. (1887) 78 pp., 11 pls.

Short diagnoses of the families are given, and the several genera contained in each enumerated, so that the work becomes a handbook to the group; thirteen new species, and one new genus—*Paralamprops*—are described.

'Challenger' Phyllocarida.*—Prof. G. O. Sars has a report on the interesting forms allied to *Nebalia*, the zoological position of which has been so much discussed. For the group we must adopt Packard's name of Phyllocarida, as it has some slight priority over Claus's term of Leptostraca. Prof. Sars is inclined to agree with Dr. Packard in believing that the Nebaliidæ may have descended from some Copepod-like ancestors, whereas they do not show any relation whatever to the Podophthalmata, which probably developed independently by a separate line from some Nauplius- or Zoëa-like form. Prof. Sars thinks that the other Branchiopods may be derived from the same line as the Nebaliidæ, the former having apparently become rather considerably modified in various ways to adapt themselves to the somewhat exceptional conditions under which they live, whereas the Nebaliidæ have still preserved much of the external appearance which may have distinguished the progenitors of the order, while their internal organization has become much more modified. A new genus—*Nebaliopsis*—is instituted for forms in which the branchial legs are imperfectly developed, the exopodites and endopodites being only slightly indicated as small triangular lobes, while the epipodite is well defined.

Structure of Cyprinidæ.†—Dr. A. Garbini has investigated the anatomy and histology of *Cypridina mediterranea*.

(1) *Antennules.*—The eight little cupping-glass structures ("ventose") situated on the branches of the antennules are described. They serve the male as external sexual organs for grasping the female. Quite distinct from these are the two large stalked discoid expansions at the base of the antennules, which appear to be olfactory or tactile organs.

(2) *Alimentary System.* (*a*) *The buccal portion.*—(1) The upper lip bears a variable number of glandules, with granular content, opening on the inferior free margin, and functional during eating. There are two others on the upper portion of the labrum, differently disposed, two in number, and apparently comparable to salivary glands. (2) Œsophagus. The walls exhibit four layers, (1) chitinous, (2) epithelial, (3) longitudinal muscles, (4) circular muscles. An epithelial circular partition lies at the union of fore- and mid-gut. Special muscles serve to elongate the œsophagus. (*b*) *The mid-gut.* Its walls consist of three tunics, (*a*) epithelial, (*b*) muscular, (*c*) pigmented. The first is most important. No hepatic cæca were to be seen. The cells of the internal tunic discharge digestive functions. The passage from mid- to hind-gut is guarded by a kind of sphincter. (*c*) *The hind-gut.* There are again three layers, (*a*) epithelial, (*b*) longitudinal muscles, (*c*) circular muscles. The histology of the different regions is noted.

(3) *Central Nervous System.*—The cerebral ganglion is very well developed. The peripheral nerve-cells are all of moderate size. Four divisions may be distinguished. These spaces contain a granular substance. The connection between the latter and the ganglionic cells

* Report of the Voyage of H.M.S. 'Challenger,' lvi. (1887) 32 pp. and 3 pls.
† Bull. Entomol. Soc. Ital., xix. (1887) pp. 35–47 (5 pls.).

was not determined. His description of the rest of the nervous system does not reveal any fact of special importance.

(4) *Sense-organs.*—The median eye and the frontal organ are strictly inseparable structures. The structure and movements of the former are briefly described. The structure and nervous relations of the latter clearly point to a sensory function. Its connection with the eye is described.

(5) *Reproductive Organs.* (*a*) *The Male.*—The testes are spherical and lateral in position, slightly in front of the rectum. The epithelial cells giving origin to spermatozoa, and the rigid form of the latter are described. The vasa deferentia with delicate elastic walls, with an anterior epithelium like that of the testes, with a posterior epithelium near their union, apparently glandular, are then described. They unite to form the penis, which has a funnel-like form, and a strong sheath of circular muscles. The "urethra" has a superior section like an X, but further down becomes triangular. A small sac-like reservoir is formed superiorly, and lined with cylindrical epithelium. The walls of the penis are in part glandular. A pair of thoracic appendages are intimately associated with the penis, which opens at their free extremity. They end in two chelate structures, which have an accessory glandular apparatus, and are intimately described.

(6) *The Female.*—The internal arrangements have been already described by Claus. The external sexual appendages end in two large ovoid glands, which contain small refractive spheres, mixed with numerous needle-like crystals. Bichloride of mercury in aqueous solution, in which the organisms were left for 5–7 minutes, followed by 75 per cent. alcohol, and Mayer's fluid (Kleinenberg's plus nitric acid) yielded the best results.

Vermes.

a. Annelida.

Germ-layers of Clepsine.* — Prof. C. O. Whitman deals very thoroughly with the history of the germ-layers in *Clepsine* and its allies. He commences with an account of the process of cleavage, in which bilateral symmetry early becomes established. In dealing with the history of the mesenteron he points out that the earlier endoderm cells arise beneath the cephalic lobe, and are probably budded off from the endoblasts as distinct cells; to these, others are soon added, which first arise as endoplasts, so that no line of distinction based on the mode of origin can be drawn. The larger portion of the mesenteron, or all but a small œsophageal portion, passes through several stages of development; the first is represented by three large macromeres or endoblasts, the second by endoplasts (each a nucleated mass of protoplasm without cell-boundary); the third by an exceedingly thin layer of flattened epithelium, and the fourth by a columnar epithelium.

Fresh arguments and evidence are brought to prove that the entire ventral nerve-chain arises as two simple longitudinal rows of cells, and that each row is produced by the continued proliferation of a single cell —the neuroblast. Connected with the neural cell-row is another which the author calls the nephric, and evidence is afforded that the nephridia are derived from the ectoderm, that they make their earliest appearance

* Journ. of Morphology, i. (1887) pp. 105–82 (3 pls.).

in the form of simple, longitudinal cell-strings, and that each nephridial cell-string is a product of a single terminal cell—the nephroblast. It is suggested as an explanation of the divergent accounts which have been given as to the origin of the nephridia that both mesoblasts and nephroblasts arose primarily from a common ectodermic basis; the genetic relations of the two cells have remained essentially the same, but the time of their differentiation as distinct cells varies. If the division takes place within the ectoderm, then each makes its exit from the original seat separately and independently of the other; if, on the other hand, division is delayed until after the separation from the ectoderm is accomplished, then the nephroblast appears to arise from the same source as the mesoblastic bands, and thus to form a part of them.

There is a special note on the significance of the teloblasts or blastomeres derived from the posterior macromere of the dividing ovum; they are one of the most remarkable features of annelid development, and represent specialized centres of proliferation, with most marvellous powers of assimilation and reproduction. The author regards them as constituting the trunk-bud, and as thus being the primary seat of all the truly metameric elements of the animal. Primarily they represented the basis of non-metameric organs, in which the regenerative power was, or became, pre-eminent. He refuses to recognize the tenability of the theories which regard the somites of segmented animals as derivatives of gut-pouches, and declares that metamerism does not first exhibit itself either in the archenteron or the mesenteron.

Salivary Glands of Leech.*—Sig. D. Bertelli has investigated the structure of the salivary glands in *Hirudo medicinalis*. These glands are situated at the so-called roots of the jaws. They are unicellular, nucleated, pyriform, and very numerous. Each has an efferent duct, and contains a granular substance which is also observed to occur in the ducts. These proceed upwards, penetrate the jaw beside the elements forming the root, and open on the free margin. By setting the animal to work, and then rapidly examining the jaws in a 1/2 per cent. salt solution, the author was able to observe the granular substance flowing from the free margin.

Germ-bands of Lumbricus.†—Prof. E. B. Wilson has a preliminary notice of his study of the development of *Lumbricus olidus* (= *L. fœtidus*). As in the species examined by Kowalevsky and Kleinenberg, the germ-bands end behind in a pair of large "mesoblasts" at the expense of which the bands increase in length throughout the whole course of development. As development proceeds six other large cells are added, and these eight may, in the language of Whitman, be spoken of as teloblasts. Each of the eight gives rise to a row of cells, at first single, which extends forwards between the ectoblast and endoblast; the rows proceeding from the "mesoblasts" soon widen into a pair of broad plates which ultimately give rise to the septa, muscles, vessels, and possibly setigerous glands. The six remaining rows are intimately related to the mesoblast. The two inner rows give rise to the halves of the nerve-cord, and their large cells are, therefore, neuroblasts precisely as in *Clepsine;* the adjoining rows will give rise to the nephridia, and

* Proc. Verb. Soc. Toscana Sci. Nat., v. (1887) pp. 284–5.
† Journ. of Morphology, i. (1887) pp. 183–92 (1 pl.).

are therefore nephroblasts; the ultimate fate of the remaining pair of rows has not yet been made out.

The neuroblasts fit closely into the ectoblast, and in some cases unquestionably extend to the outer surface. The ventral nerve-cord is formed by the gradual concrescence of the neural rows in the median line; there is no invagination from the exterior, and the continuity of the ectoblast across the median line is never broken. Unless there is a great difference between *L. rubellus* and *L. olidus*, Dr. Hatschek must have mistaken the narrow angular interval between the converging halves of the cord as evidence of invagination.

The nephridia and their nephroblasts have a very similar history to the nerve-cord and neuroblasts; the nephridia arise as paired metameric outgrowths from the nephridial rows, and there is in each somite a single pair.

The mesoblastic bands arise as single rows of cells at the latero-posterior angle of the mesoblasts, curve round their outer sides so as nearly to meet in the middle line, then bend rather abruptly outwards and run forwards; they soon become broad bands that pass between the endoblast and the remaining six cell-rows. They give rise to all the muscles and vessels of the body, as well as to the ciliated funnels and outer investments of the nephridia. Not only the neuroblasts, but also the nephroblasts and "lateral teloblasts" appear to be modified ecto-blastic cells. Prof. Wilson cannot doubt but that the nephroblasts are derivates of the outer germ-layer, and thinks, consequently, that the likeness between the development of the nephridial row and that of the segmental duct of vertebrates (as recently described by Spee and others) is very significant, for in the rabbit, the guinea-pig, and *Raja*, the segmental duct has been found to arise as a solid cord of cells that is split off from the outer layer, and grows at its hinder end by the proliferation of a limited area of the ectoblast. The conclusion is arrived at that the "nephridial row" of *Lumbricus* must be regarded as homologous with the segmental duct, and the series of nephridia as homologous with the vertebrate pronephros.

The likeness between the germ-bands of *Lumbricus* and *Clepsine* seems to indicate a very close relationship between the Oligochæta and the Hirudinea; the development of the six anterior teloblasts in *Lumbricus* may be explained as due to the greater and greater concentration of developments at the posterior ends of the germ-bands; they are at first ordinary ectoblast cells which afterwards sink below the surface. In *Clepsine* they are covered by the ectoblast at a very early stage owing to acceleration of development.

Photodrilus phosphoreus, Type of a New Genus of Phosphorescent Lumbricids.*—M. A. Giard establishes a new genus for the *Lumbricus phosphoreus* of Dugès. It was observed by him at Wimereux, and the light was seen in points of a fine opalescent green. The luminous points were of unequal size, the largest giving a light as bright as those of the Lampyridæ, and being visible even in a well-lit room. If one of the points was rubbed between the hands, the two palmar surfaces were for a short time luminous, and near each point a small earthworm was found. *Photodrilus phosphoreus* is 45 to 50 mm. long and about 1·5 mm. wide; it has about 110 segments; the skin is very transparent and

* Comptes Rendus, cv. (1887) pp. 872–4.

richly vascular; the setæ are not bigeminate but separated as in *Pontodrilus*. There is no distinct buccal segment, and only one pair of copulatory pouches. The clitellum extends from the thirteenth to the seventeenth ring, the female orifices are on the fourteenth, and the male on the eighteenth. The digestive tract has a protrusible proboscis, and as it comes and goes one may see on the lower surface of the buccal segment a tuft of long clear filaments which are very delicate, and are sometimes transversely striated. It is possible that they are the homologues of the cylindrical rods described by Prof. Perrier in the interior of *Pontodrilus*, or they may be broken muscular fibres. The gizzard is replaced by four swellings; the œsophagus is invested dorsally and laterally by large glands which decrease in size from before backwards; these are regarded as being homologous with the septal glands described by Dr. Vejdovsky in the Enchytræidæ. Notwithstanding their position, these are not enteric glands, and they open on the dorsal surface; the author thinks that the photogenic property of *Photodrilus* is due to the secretion of these glands. The circulatory apparatus differs little from that of *Pontodrilus;* there are two pairs of testes, and one pair of ovaries. As Dugès' worm was found in hot-beds in the Jardin des Plantes at Montpellier, and the Wimereux specimens in a cultivated garden to which earth had been brought by a horticulturist, it is probable that the species is not French but exotic.

Enchytræidæ.*—Dr. W. Michaelsen has made a preliminary systematic study of the interesting family of Enchytræidæ. His system is as follows:—

Setæ S-shaped.

Head-pore large, at or near point of head-lobe. No salivary glands. Colourless blood. Dorsal vessel with heart. Vas deferens short; at most, eight times longer than the seminal funnel. *Mesenchytræus* Eisen.

Head-pore small between head-ring and lobe. Long vas deferens. No salivary glands. Blood yellow to red. Dorsal vessel without heart. *Pachydrilus* Claparède.

Short salivary glands opening into œsophagus. Blood colourless. Dorsal vessel rises from a diverticulum in VII. segment. *Buchholzia* Michaelsen.

Setæ straight, with only a slight internal curvature.

Head-pore small between head-ring and head-lobe. Blood colourless. Dorsal vessel without heart. Salivary glands usually well developed. Vas deferens long. *Enchytræus* Henle.

Setæ aborted.

Head-pore large at apex of head-lobe. Blood colourless. Dorsal vessel with heart. An unpaired salivary gland on the intestine. Vas deferens long, more or less regularly spiral. Seminal sac large, intruding freely into the body-cavity, not coalescent with the gut. *Anachæta* Vejdovsky.

Parasite of Telphusa.†—Signor W. Drago has described a parasite which Prof. B. Grassi found some time ago on the gills of *Telphusa fluviatilis* in considerable abundance. It was at first suspected to be a *Branchiobdella*, but was soon recognized as an oligochæte. It is in fact

* Arch. f. Mikr. Anat., xxx. (1887) pp. 366–78 (1 pl.).
† Bull. Soc. Entomol. Ital., xix. (1887) pp. 81–3.

a new genus and species of Enchytræidæ, and from its host and habitat (Catania) has been called *Epitelphusa catanensis*.

Signor Drago describes the main features in the structure of this worm which attained a maximum size of 15 mm. If it is to be admitted among the Enchytræidæ, some of Vejdovsky's characters of the group must be somewhat modified, especially as regards the pair of protractile gustatory lobes, the hard and resisting integument, the presence of a pair of salivary glands, the nature of the lateral vessels and of the clitellum. The genus *Epitelphusa* may be distinguished from *Pachydrilus*, *Enchytræus* and *Anachæta* by the following characters. The epidermis without cuticle. The setæ straight and short. The blood coloured. The dorsal vessel with four lateral vessels. The absence of the so-called gustatory lobes. The septal organs between IV. and V., V. and VI., VI. and VII., segments. The receptacula seminis open between segments IV. and V. The clitellum extends from XI. to the anterior portion of XII. The testes in "bouquet" form as in *Pachydrilus*.

Anatomy of Polychæta.*—Mr. J. T. Cunningham takes occasion to point out the general inaccuracy of Cosmovici's essay on the "Glandes génitale et organes segmentaires des Annélides Polychètes" published in 1880. His account of the nephridia and gonads is, however, very correct, but he separates in "an absurd manner" the nephrostomata from the nephridia; a few corrections are made in his observations. In *Cirratulus cirratus* both the large anterior pair of nephridia described by Keferstein and Claparède, and the series of pairs in the middle and posterior region mentioned by Cosmovici are present; the simple nephridia act as efferent ducts for the reproductive elements; the position of the gonads of this species is still doubtful. *Nerine cirratulus*, which has not hitherto been recorded as British, is common between tide-marks at Granton; in it the relations of the nephridia are in some small points exceptional; the nephridial aperture is extremely dorsal in position, and the efferent duct is long; in it and *N. coniocephala* the nephridia serve as the ducts for the gonads. Cosmovici's account of the nephridia of *Lanice conchilega* is erroneous; we have already † noticed Mr. Cunningham's discovery of the remarkable coalescence of nephridia seen in this species. The identity of *Pectinaria belgica* and *Amphitrite auricoma*, urged by Mr. Harvey Gibson, is disputed; *P. belgica* has three pairs of nephridia, of which the first are the largest; all the organs are of the usual type, but a peculiar glandular organ, of unknown function, lies between the nephridial opening and the root of the branchia. The gonads are, as usual, masses of undifferentiated cells. In *Nereis virens* the generative products appear to escape by dehiscence.

The curious organ called the "cardiac body" has been examined in some Chloræmidæ, Terebellidæ, and Cirratulidæ.

Mr. Cunningham has examined the neural canals of various Polychæta, and comes to the conclusion that they are supporting structures which serve to prevent the nerve-cords being bent at a sharp angle, and so being injured during the wriggling and burrowing of the worm; it is noticeable that the canals always reach their highest development in worms which are extremely long in proportion to their thickness; their maximum development is seen where the nerve-cord is not separated

* Quart. Journ. Micr. Sci., xxviii. (1887) pp. 239–78 (3 pls.).

† See this Journal, 1887, p. 591.

from the epidermis, or, in other words, where it is more exposed to the danger of being injured than when more internal in position.

Annelid Genus Spinther.*—Prof. L. v. Graff gives an account of the polychætous genus *Spinther*. After an historical introduction and some general remarks the author gives a full definition of the genus; the body is elliptical, all the segments except the cephalic and anal have, in addition to a pair of short marginal parapodia, paired dorsal dermal folds, which arise above the parapodia and extend as far as the middle line of the strongly curved back. Both the lamellæ and the parapodia radiate from the foci of the ellipse. At the base of the dorsal tentacle are four small eyes covered by integument. The upper free surface of the dorsal lamellæ is supported by chitinous spines which are ordinarily arranged in two rows, but the tips only of these spines project. The two ventral nerve-cords are widely separated, and have but feeble segmental swellings. The pharynx is tongue-like, muscular, and protrusible, with a ventral groove; there is no maxillary apparatus; the midgut has paired diverticula, and the hindgut gives off a forwardly directed dorsal cæcum. There are no special gills or segmental organs, and the sexes are separate. The worms live on marine sponges to which they attach themselves by their setæ. Definitions of the species follow; of these there are three—*Spinther oniscoides*, *S. miniaceus*, and *S. arcticus*. The second of these is the most widely distributed, and its varieties show relationship sometimes to *S. oniscoides*, and sometimes to *S. arcticus*. *S. miniaceus* must be regarded as the primitive species. Full anatomical details are given.

The peculiar elliptical form of the body of *Spinther* (and *Euphrosyne*), with the radial arrangement of the segments anteriorly and posteriorly, as well as the gradual shortening of the segments and their appendages towards the anal end of the body, are certainly not primary structures; here, as in the very similar Myzostomida, the radial configuration of the body must be regarded as the consequence of an adaptation to the parasitic fixed mode of life. In both groups the ancestor must be sought for in elongated forms with equally developed somites, but we cannot yet say where this ancestor of *Spinther* is to be looked for.

Structure of Serpula.†—Sigr. V. Simonelli has investigated the microscopic structure of *Serpula spirulæa* Lam., and finds that his results furnish new evidence in favour of that separation of this species which Defrance (1847) long since suggested. He describes the complex structure of the limy tube, which he succeeded in satisfactorily sectioning, and shows how it differs from other Annelids. Nor can the species be ranked beside *Vermetus*. *S. vertebralis* and *S. heliciformis* were also studied, which closely resemble *S. spirulæa*. It seems at least necessary to drop the title *Serpula* as applied to these forms, and to revive the generic titles *Rotularia* or *Spirulæa*.

β. Nemathelminthes.

Maturation and Division of Ascaris Ova.‡—Prof. J. B. Carnoy laid the results of his observations before a conference of microscopists at Brussels.

* Zeitschr. f. Wiss. Zool., xlvi. (1887) pp. 1–66 (9 pls.).
† Proc. Verb. Soc. Toscana Sci. Nat., v. (1887) pp. 293–5.
‡ La Cellule, iii. (1887) pp. 225–45.

I. First of all, in regard to the kinetic phenomena of maturation, he maintains that the primitive nucleus of the ovum is an ordinary nucleus; that it divides into eight batons ("tronçons") in two groups of four; that there are always two polar bodies in *A. megalocephala;* that there are no globules, nor chromatic discs, nor prothyalosoma; that the typical kinetic figures are dimidial; that the ypsiliform figure does not exist as such. A new spindle of separation is formed, again a dimidial figure, again no globules, discus, nor prothyalosoma. Each semi-spindle bears at its equator two of the primitive batons. One of the groups is isolated with the second polar body. The other remains in the ovum. The two last batons form the final nucleus. The polar bodies owe their formation to a true plasmodiæresis, by the aid of a cellular plate. They are true cells, and not nuclei. II. Variations of polar kinesis. The author distinguishes three different types within the same genus *Ascaris*, and maintains the great variability of the polar kinesis. III. The cellular plate. In animals cell-division (plasmodiæresis) is accomplished by constriction, by aid of a cellular plate, or by both processes at once. The cellular plate occurs in all kinds of cells. It occurs distinctly in the formation of the polar bodies of Nematode ova.

Polar Bodies in Ascaris.*—Prof. J. B. Carnoy adds several appendices to his well-known, much-criticized, investigations on the phenomena of maturation, fertilization, and division of *Ascaris* ova. He describes the formation of polar bodies in *A. clavata* and *A. lumbricoides*, noting the transversal equatorial division, the incomplete longitudinal division, its possible retardation, the occasional absence of the polar ascent, the normality of the polar kinesis, the diverse modes of separation to be seen in one preparation. A second appendix is devoted to a discussion of the normality of the figures. He emphasizes the fact of individual variations. Some observations are made anent the critique of the Hertwigs, and the method pursued by Boveri. A third appendix is for the most part an answer to Flemming, and discusses the facts of variation in kinesis, maintaining the impossibility of any general formula. In reply to Flemming's strictures on the new terminology, Carnoy criticizes the old, and justifies his own.

Fertilization of Ascaris megalocephala.†—Prof. O. Zacharias has made a fresh study of the process of fertilization in the case of *Ascaris megalocephala*, which has been honoured with the attention of so many naturalists. He gives at the outset a short sketch of the well-known series of researches on this subject, he notes the various points of contrast, for instance, between Nussbaum and Van Beneden, between Carnoy's and Hertwig's theory, and so on, and expresses at the outset his conviction that what all observers from Auerbach onwards have regarded as pronuclei are structures of entirely different import.

I. *Ova and Spermatozoa.*—The author proceeds to describe the reproductive elements themselves, noting the changes in the maturing ova, the early hyaline spherules and cavities, the appearance of a membrane, the peripheral position of the nucleolus and its various parts, the subsequent division into two portions, the further division of each of these into four, the differentiation of each of these into connected rows

* La Cellule, iii. (1887) pp. 247–324.

† Arch. f. Mikr. Anat., xxx. (1887) pp. 111–82 (3 pls.). For the author's method see *infra*, Microscopy β.

of spherules, and the appearance of two separate spindle figures. At the very first there is dualism, each half contains an equal number of chromatin rods; the dualism is still preserved in the formation of the two polar bodies; a double fertilization also occurs; each of the chromatin portions unites with half of the sperm chromatin; two segmentation nuclei are formed, which have, however, a single functional import, since each furnishes at the beginning of segmentation two chromatin coils for the single mother-star of the first segmentation. *The two segmentation nuclei have been wholly misunderstood, and erroneously interpreted as pronuclei.*

The germinal spot or so-called nucleolus includes all the formed chromatin substance of the ovum, it is rather comparable to a nucleus, it is a structure *sui generis*, and to it, as to the similar body in the sperm, the designation mitoblast may be applied.

Prof. Zacharias then describes the male elements, noting the successive changes, the amœboid and the passive portion, the important naked mitoblast which does not deserve the name of nucleus, denying that the sperm and ovum are, as Nussbaum says, homologous, while acknowledging that they are complementary cells. He takes a brief survey of incipient dimorphism of sexual elements, and maintains the fundamental physiological and histological differences between ovum and sperm.

II. *The Conjugation of the Sex-cells.*—While in the main corroborating the classic results of Van Beneden, the author differs from him in sundry details, especially as regards the mode in which the sperm penetrates the ovum. He finds, for instance, no micropyle. The egg substance never forms a naked protrusion to serve as the attaching point for the spermatozoon. The penetration of the sperm begins with the emission of pseudopodia, but the rest of its progress appears to be passive. By some local regeneration, the membrane closes upon the entrant sperm. The sperm has in itself power to penetrate the membrane. In regard to the point where the sperm may enter, Zacharias observed that in the elliptical ova of *A. suilla*, the male elements were seen fixed both at the pole, and on the sides. Polyspermy occasionally occurs, but is to all appearance pathological. It may be that the ovum, being amœboid and exhibiting contractions, may form a small cone of attraction into which one sperm normally finds its way. The membrane thickens after the entrance of one sperm. Some notes on the genital ducts are then made.

III. *Formation and expulsion of Polar Bodies.*—The double structure which results from the originally single germinal vesicle, has been already noticed. The two half-spindles occupy various relative positions. The ypsiliform figure so familiar in Van Beneden's researches is only a special, and not a typical form of spindle. The division forming the polar bodies takes place radially, and not tangentially to the surface of the yolk, the difference on which Van Beneden lays so much stress does not occur in properly killed and fixed ova. The extrusion of the second body is also normal in its karyokinesis. In the first extrusion the original number of chromatic elements is halved and thus reduced to four, in the second process half is again given off, so that three-fourths of the female chromatin is excluded from share in the embryonic development. At the time of the second polar body formation, the dualism of the male element is well marked. This chapter closes with

a discussion of the biological import of polar bodies, in which Zacharias seems more inclined to side with Bütschli and with Weismann, than with Minot or with Strasburger.

IV. *The act of Fertilization.*—There are two pairs of conjugating elements, male and female semi-mitoblasts. The result is two nuclear structures mistaken for pronuclei, each consisting of a male and a female semi-mitoblast. Hertwig's theory is entirely confirmed, though stated in a new form. The whole point is that the union of sexual elements is double, not single.

V. *The Segmentation.*—A single segmentation nucleus is formed eventually. The details of division are described. Zacharias confirms Flemming's formula of repetition, according to which the daughter-nuclei pass into rest by the star and coil stages, through which the mother-nucleus passed out of it. The memoir, which is (unlike some others of the kind) lucid and unambiguous throughout, closes with some general notes on the relative importance of nucleus and protoplasm.

Larval Stage of Species of Ascaris.*—M. A. Laboulbène, in opposition to the recently expressed views of Dr. Linstow, affirms that *Ascaris lumbricoides* developes directly, or without the intermediation of a second host. The ellipsoidal ova are evacuated before they have undergone any segmentation; the formation of the embryo takes about thirty or forty days with a favourably high temperature, but may, as Davaine has shown, be retarded for as long as five years with a low temperature and a damp atmosphere. The embryo, as seen in the egg, has an obtuse head, no lips, valves, or cephalic nodules; its tail is merely acute, and not filamentar. This embryo quits its egg-shell in the stomach, or more often in the small intestine of the animal which it has reached; the shell is softened merely, and not dissolved by the gastro-intestinal juice. The embryos now rapidly pass through a larval stage; twice only has the author seen it; the first example was filiform, 20·4 mm. and 0·5 mm. wide, and its head had three valvular and nodulose projections; the caudal extremity was truncated below, and no genital organs were apparent. On the second occasion M. Laboulbène found four examples, the exact dimensions of which were 2 mm., 3·25 mm., 1 cm., and 2·3 cm. He concludes that the development of *Ascaris lumbricoides* is direct, the segmenting ovum giving rise in the body of its definite host to the embryo, which rapidly reaches and soon passes through the larval to reach its sexual condition. The experiments of Grassi have shown that ripe ova may furnish sexual Ascarids at the end of a month after swallowing.

The ova of Ascarids, after passing with the fæces, are washed away by rains, when they make their way into streams and ponds; by watering they are deposited on food-plants, and the evaporation of water allows of their preservation in damp places. In the case of the dog the eggs remain entangled in the hair, and the young, which lick their parents, easily come into contact with them. The comparative rarity of this human parasite in towns, and its frequency in rural places, is to be explained by the fact that in the former the water generally is, and in the latter is not filtered.

* Comptes Rendus, civ. (1887) pp. 1593–5.

γ. Platyhelminthes.

Cestoid Embryos.*—Mr. E. Linton describes and figures two forms of cestoid embryo which he frequently met with in studying the entozoa of marine fishes.

The first cyst described was taken from the peritoneum of the blue-fish (*Pomatomus saltatrix*), and similar forms are common in Teleostei, occasional in Selachians. It contained an embryo *Rhynchobothrium*. The thin, transparent, delicate outer cyst inclosed an endocyst (blastocyst of Diesing). The latter was usually a club-shaped, thick-walled sac, and remained active for hours with alternate contractions and expansions. The embryo lay in a coil at the large end. The water vascular canal could be seen through the cyst. The wall of the cyst had two coats, the outer of three layers, granular, muscular and refractile. The endocyst may be regarded as an intermediate or transition form, a nurse to the embryo. The freed embryo was quite active and measured about 24 mm. The bothria were two, marginal, oblong, divergent posteriorly, notched on the posterior border, obscurely two-lobed, with free mobile edges. There were four long slender proboscides armed with recurved hooks. These are described in detail. The proboscis-sheaths are long and spiral and exhibit a contractile ligament. The contractile bulbs were thick-walled, acting like syringes, forcing a column of fluid into the proboscides. The bothria are then described. The water vascular system consists of a network of vessels on the borders of the bothria, connected with large sinuous vessels in the centre of the head, and together with these with the reticulated subcuticular vessels of the neck. Behind the contractile bulbs the system is represented by two pairs of lateral sinuous vessels. Behind the bulbs the body is an elongated sac filled with granular parenchyma, with refractive masses smaller than those of the cyst. The posterior end is terminated by a papillary button-like process, retractile, and covered with dense minute bristles.

The second cyst described was that of an embryo *Tetrarhynchobothrium*, taken from the surface of the liver of the cero (*Cybium regale*). It was long, slender, yellowish and opaque. The freed blastocyst was also long and slender with a neck-like constriction at one end. The head-part thus formed was extraordinarily variable. The whole body exhibited irregular contractions and expansions. The embryo lay in a coil in the head-part. The blastocyst remained attached to the body of the liberated scolex. It would not be readily separated. The posterior tapering end of the scolex was again clothed with bristles. The bothria are four, in opposite lateral pairs, are quite mobile, each with a retractile hooked proboscis. The proboscides were as fully developed as in the *Rhynchobothrium* embryo. The sheaths were spirals, the contractile bulbs slender. A reticulated system of vessels was made out. The connection of blastocyst and scolex is a marked difference at the period in question between this embryo and that above described.

Tænia nana.†—Prof. B. Grassi (with the assistance of Signor S. Calandruccio) has a second preliminary note on this small human Cestode. The rostellum may project, like a proboscis, very far from the head, and it may be drawn very far in. In the latter state it has the form of an hourglass; it lies in a sac with a thick wall which has an

* Amer. Naturalist, xxi. (1887) pp. 195–200 (1 pl.).
† Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 282-5.

anterior orifice. When protruded, part of the wall of the sac is protruded with it. The rostellum is provided with longitudinal and circular muscles, and in the sac there is a circular musculature from which numerous bundles of oblique or longitudinal fibres are given off. There are from twenty-four to twenty-eight hooks on the rostellum. The suckers can elongate like arms, and each is capable of independent movement. They and the rostellum may break off mechanically from the scolex, without the latter suffering any apparent injury. The neck may vary in length. The proglottids differ remarkably in form and number; one very important characteristic is that their hinder angles project in the form of more or less regular triangular points. The separate joints have a certain power of shutting in upon one another.

By the examination of well-preserved eggs the authors have been able to see that the substance in the space between the two egg-membranes is often homogeneous near the inner membrane, and that the latter has two scarcely evident swellings, one of which corresponds to the pole of the egg, while the other is just by the other pole. In certain cases it is easy to see that the coiled filaments in the substance correspond to the two swellings. The longest axis of the egg is from 43–53 μ long, the shortest from 35–40 μ.

Tænia murina from the mouse is probably a mere variety of *T. nana*, differing chiefly in its greater length, and in the ordinarily greater size of the just mentioned swellings.

Fourteen new cases of *T. nana* have been observed, chiefly in children; and it may be said that *T. nana* is much more common than other human cestodes in Sicily. To discover it, it is not sufficient to examine fæces once only. The number present varies from forty or fifty to four or five thousand; the hosts frequently suffer little or no pain, but this, of course, is not always the case. *Filix mas* is an appropriate remedy.

Sphyranura osleri.*—Prof. R. Ramsay Wright and Mr. A. B. Macallum give a detailed account of this ectoparasitic Trematode, which is intermediate between *Gyrodactylus* and *Polystomum*, and may, if some slight alteration be made in the diagnosis, be placed in the subfamily Polystomidæ, as defined by Taschenberg. *Sphyranura* is found on the skin of Menobranchs, where it is very obvious on account of its want of colour.

The investing membrane is very elastic and is provided with a very large number of conical bodies, which the authors regard as tactile organs; the deep surface of the membrane does not lie on the circular muscles, but is separated from them by a narrow space containing fluid; the presence of tactile organs may be correlated with the comparatively active life led by this parasite, and as compensatory for the absence of eyes. The worm holds on to its host with great pertinacity, owing to the possession of hooks and suckers on the ventral surface of the characteristic caudal lamina. The most striking point about the musculature is the fact that the diagonal fibres, which are so abundantly present in the larger Distomes, are hardly represented. With regard to the minute structure of the muscles, as to which various students of Trematodes have given different accounts, the authors tell us that the longitudinal caudal bands, which are generally over 2 mm. in length, offer favourable material for the study of individual fibres. They find that

* Journ. of Morphology, i. (1887) pp. 1–48 (1 pl.).

many of the cells of the sub-cuticular layer are in reality the central protoplasmic elements of the muscular fibres, the contractile elements of which form the musculature on which the investing membrane rests. The fibres consist of a hyaline membrane covering a finely granular and apparently fluid medulla.

The connective tissue of *Sphyranura* is composed of branching cells which form a meshwork; their processes, which are evidently elastic, are homogeneous, the cells are oval, spherical, or irregular in shape, and the greater part is occupied by the nucleus, with little or no protoplasm surrounding it.

The excretory system is provided with two anterior contractile bladders which open by dorsal pores; applied to their walls are large ganglion-cells which, presumably, control their pulsations; these are effected by the muscular fibres which line the bladders. Each bladder has connected with it a strong lateral stem which gives off numerous twigs to the caudal lamina; the walls of the trunks are highly elastic, and are, in parts at any rate, provided with muscular fibres. The walls of the finer excretory capillaries rarely exceed 1 μ in thickness, and seem to be formed by a single coat of a homogeneous refracting substance; at certain points these capillaries present a funnel-shaped expansion, where the membrane terminates; beyond the mouth of the funnel there is a network of fine intercellular canaliculi; the mouth lies in the interior of a connective-tissue cell, and the fine canal which leads to it passes through the cell-substance. The funnel, as well as the capillary into which it empties, always has a distinct wall up to the rim of its broad mouth. Cilia hang over this rim into the funnel.

In connection with the excretory system of *Sphyranura* the authors describe some remarkable structures which have not, apparently, been observed in other Trematodes. Cells of a polyhedral shape, sometimes with short processes at the angles, and measuring from 37–50 μ, are found scattered throughout the body. The cytoplasma forms coarse trabeculæ, which usually radiate from the centre of the cell to the periphery, and contains a system of communicating spaces which are empty in the fixed, but often unobservable in the fresh condition; each cell has at one pole a process, with an axial wavy channel connected with one of the neighbouring excretory capillaries, the wall of which passes insensibly into the membrane of the cell. This connection suggests that the cells in question are truly renal. With them somewhat similar structures in other Trematodes are compared.

The authors have never seen the nervous system so well during life as in *Sphyranura*, the fibrillation of the plasma of the ganglion-cells being distinctly seen. The ganglion-cells form two masses which are not grouped round the pharynx, but lie at its sides; these ganglia are connected by two commissures, the stouter of which is supra-pharyngeal, and the more slender infra-pharyngeal; on either side are two nerve-stems, which are lateral and ventro-lateral in position, the dorsal stems of *Distomum isostomum* being, apparently, absent from this form. The system of connecting commissures is described.

The digestive tract is without an œsophagus; the intracellular mode of digestion plays only a subordinate part; the soluble digestive ferment seem to be derived from the cells of the intestinal epithelium. Though this new form is hermaphrodite, the male and female organs are quite independent of each other; the author's observations on spermatogenesis

agree generally with the account given by Schwarze of *Distomum endobolum*, but they are confident that the spermatozoa arise wholly from the nuclei of the sphere or spermatogemma. They have been able to observe the passage, under pressure, of the female sexual products to the intestine through the overflow-tube, and regard this as a confirmation of Ijima's discovery of the true nature of the so-called internal vas deferens of *Polystomum*. Some details are given as to the minute structure of the female organs; in the ovary there are parietal cells, varying considerably in size, and from them arise, by increase in size and division, the cells which fill the cavity of the ovary; the ripe ova measure about 55–60 μ, and their nuclei about 35–40 μ. The uterus never contains more than one egg, and the extent of development of this seems to stand midway between the advanced condition found in *Polystomum oblongum* and *P. ocellatum*, and the early oviposition which occurs in *P. integerrimum*.

New Human Distomum.*—M. J. Poirier describes, under the name of *Distomum rathouisi*, a new species of fluke obtained through Père Rathouis, and taken from a Chinaman thirty-five years of age. As the patient suffered for a long time from hepatic derangements, which were refractory to all remedies, it is probable that this new endoparasite inhabits the biliary canals. In a number of characters it resembles *D. hepaticum*, but is distinguished from it by the large size—2 mm. in diameter—of the ventral sucker, by the absence of spinous processes from the integument, and by the absence of ramified cæca connected with the two branches of the intestine, as well as by the smaller size of the elements of its parenchyma, and by the structure of its uterus.

Natural History of Leucochloridium paradoxum.†—Herr G. Heckert has found that *Leucochloridium paradoxum* is not rare near Leipzig. It is, as is well known, the sporocyst stage of *Distomum macrostomum*, and is found in the liver of the snail, where it forms a network of multiramified tubes which are filled with a serous fluid, germ-spheres, and the larvæ developed from them. Parts extend into the tentacles, and thither the ripe forms make their way. Both the sporocysts and tubes are subject to a very high pressure, and if they are injured their contents are rapidly expelled. Even the young tubes exhibit contractions, which are probably of importance in metastasis; the large tubes not only effect this, but with their colour attract birds, who regard them as living larvæ; their musculature is very well developed, consisting of longitudinal, circular, and diagonal muscles. Below the dermo-muscular layer bright green pigment is found in cells, which are arranged circularly. The brown tubes sometimes seen probably belong to different sporocysts. The sporocyst and tubes are of the same histological structure; there is an external cuticle, a dermo-muscular tube, then a layer of cells which varies in size with the stage of growth, and finally a membrane with distinct cellular elements. In this last the germ-spheres arise as local thickenings, which, when they fall off, pass into the nutrient fluid which fills the sporocyst; they are chiefly made up of small cells with proportionately large nuclei, and only in the centre are there some larger cells. The spheres have at first the form of a lens which gradually becomes oval; the genital apparatus is developed from

* Arch. Zool. Expér. et Gén., v. (1887) pp. 203–12 (1 pl.).
† Zool. Anzeig., x. (1887) pp. 456–61.

the central cells first; then the sucker begins to appear, and is followed by the pharynx and enteron, excretory organ, and nervous system. The larva now undergoes a double ecdysis, but the cuticle is not lost but forms a protective covering until the *Distomum* has passed into the intestine of the bird. Between it and the cuticle a serous fluid collects, and it is to this that the animal owes its elasticity and its freedom from injury in its host's gizzard.

By feeding experiments, the author found that the Sylviidæ are the true hosts of *Distomum macrostomum*. One or two days after feeding the parasites were found in the cloaca, which is their permanent seat. About the eighth day egg-production began, and after fourteen days the *Distomum* was full of eggs.

With regard to the early stages of egg-development, Herr Heckert confirms the results of Schauinsland; the final result of segmentation is the formation of an embryo with a very thick shell; it is about 1/30 mm. long, and consists of only a few cells; at the hinder end of a ciliated comb there is a powerful cone which acts as a steering organ.

Owing to failures in further breeding, the author came to the conclusion that the eggs must be eaten by the snail, and the embryos set free in their stomach by mechanical or chemical influences. After feeding *Succineæ* with the eggs, he found that the embryos became free in about a quarter of an hour after eating; they swim about in the stomach and attempt to bore with their head-cone. After eight days, the first stages of the sporocysts were found in the liver, where they were in the form of small rounded spheres with more or less well-marked elevations, which are the first signs of the commencing branches.

Temnocephala.*—Mr. W. A. Haswell gives an account of an aberrant monogenetic Trematode found on the large fresh-water crayfish of the northern waters of Tasmania. It is a leech-like animal about half-an-inch long; at the narrower anterior end there are on either side two very long and slender tentacles, which, when fully extended, are one-half or two-thirds the length of the body. In the species from New South Wales or New Zealand there are five equal slender tentacles. The rapidity of the movements, and the extreme sensitiveness of the animals are surprising; in turning aside from a touch they show a very definite sense of direction. The author distinguishes four species which he calls *Temnocephala fasciata* (on *Astacopsis serrata*, streams of New South Wales); *T. quadricornis* (on *A. Franklinii*, northern rivers of Tasmania); *T. minor* (on *A. bicarinatus*, streams of New South Wales); and *T. novæ-zealandiæ* (on *Paranephrops setosus*, rivers of New Zealand).

Temnocephala is regarded by Mr. Haswell as most nearly related to the Tristomidæ, but the numerous peculiarities which it presents require the formation of a new family for its reception. These characters are the possession by the cephalic end of the body of slender filiform tentacles with prehensile and tactile functions; as the tentacles are adhesive they take the place of the anterior suckers; their adhesive powers are increased by the secretion of certain special unicellular glands. There is a single large radiated posterior sucker without hooks. A rudimentary segmentation is indicated by the incomplete transverse dissepiments which are formed by specialized portions of the parenchyma muscle,

* Quart. Journ. Micr. Sci., xxviii. (1887) pp. 279–302 (3 pls.).

and the intestine is constricted at regular intervals by these septa. There are three pairs of longitudinal nerve-trunks, dorsal, dorso-lateral, and ventral, which are connected by numerous commissures. The two apertures of the excretory system are placed far forward on the dorsal surface. The reproductive apparatus has a single orifice from the cloaca, into which the ejaculatory duct and vagina open; there are two pairs of lobed testes, vitelline glands which are imperfectly segmented, a single ovary, receptaculum seminis, oviduct, and uterus. As in other ectoparasitic Trematodes there is no metamorphosis of the young.

Trematode in white of newly-laid Hen's Egg.* — Dr. E. Linton records the presence of *Distomum ovatum* Rudolphi in the white of a freshly-laid hen's egg. The presence of this common avian parasite in this position is not hard to explain; its favourite place is the bursa fabricii, and an individual may well penetrate occasionally one of the passages which communicate with the cloaca. The creature is known to sometimes make its way into the oviduct, and if it should pass beyond the shell-forming glands when an ovum is *in transitu*, it might easily be enveloped in the glairy albumen which exudes from the glands; the subsequent deposition of the shell would not be interfered with.

Lateral organs of Nemerteans.†—Herr R. Devoletzky gives the complete statement of his investigations begun in 1879.

After some remarks on the methods used, and a review of former work on the subject, he describes shortly the characteristic head-furrows of Nemerteans, and then treats at length the side organs of *Terebratulus fasciolatus* in particular, and the other Schizonemerteans in general. *Drepanophorus* is the type of the Hoplonemerteans and these are also described in general. *Carinella* is next treated in detail, and the results of the investigation are correlated in conclusion. The occurrence of side organs in all three groups of Nemerteans leads to the conclusion that these are organs of special sense, and their considerable importance is shown by their complex structure and their very general occurrence. In forms before thought to be without them, careful search has revealed their existence, and it is probable that if not always persistent, they are present during some part of the life of every species.

In the simplest form (*Carinella annulata*) a simple inpushing of the outer skin is connected with the central ganglia by fibres which break through the inner skin. In *C. polymorpha* a large opening in this inner skin forms a passage from the more developed canal to the "brain" into which, in *C. inexspectata*, the canal itself extends directly. In all the higher forms a part of the central nervous system breaks through the body-wall to meet a specialized and inpushed portion of the epithelium. These side organs are compared with similar sense organs in other groups of the animal kingdom, especially water-inhabiting ones. Some Annelida and Mollusca are referred to in particular. Side organs cannot be considered to have sight, hearing, or touch as function. Smell and taste are possible since the media in which they work, water and moist air, could convey chemical stimuli to the richly ciliated canals, and to the grooves and furrows of the head. The author does not presume to advance any further hypothesis.

* Proc. U. S. Nat. Mus., 1887, pp. 367–9.

† Arbeit. Zool. Instit. Univ. Wien, vii. (1887) pp. 233–80 (2 pls.).

'Challenger' Nemertea.*—The more interesting general points in the results of Prof. A. A. W. Hubrecht have already been noted in this Journal.† Many of the specimens obtained during the voyage were fragmentary, but they were excellently well preserved for histological purposes; 19,560 sections were made, all of which were stained with Ranvier's picrocarmine. *Carinina* is a new genus allied to *Carinella;* the name of *Eupolia* is proposed for the genus of which delle Chiaje's *Polia delineata* is the type. The anatomy is considered in detail, and the memoir concludes with some general considerations.

δ. Incertæ Sedis.

Parasitic Rotifer—Discopus Synaptæ.‡ — The Rotifer noticed twenty years since by Prof. E. Ray Lankester as living parasitically in *Synaptæ* at Guernsey has been found on the same Holothurian by Dr. C. Zelinka. The worm is not, however, endoparasitic, but lives as a "free space-parasite" in small pits on the skin. This form, which the author calls *Discopus Synaptæ* g. et sp. n., is one of the Philodinidæ; it is distinguished from all known genera by the following characters. The foot ends in a sucker with a broad round disc and two short pincers; there is no contractile vesicle; the cement-glands are formed of cells attached to the ventral walls in two semicircular rows, and their efferent ducts, after various loopings, divide repeatedly and finally open on the last joint of the foot by means of pores arranged in a circle. The animals exhibit four kinds of movements, they either progress like a leech, or they make tactile movements by extending their bodies, or by moving from right to left, or they swim with the foot retracted and the wheel-organ extended. The skin, which is not at all thick, except in the wheel-organ, proboscis, and foot, consists of a cuticle or syncytial hypodermis. The dermo-muscular tube consists of eleven delicate circular muscles, and a dorsal pair of longitudinal muscles, which have the same structure as in *Callidina*. The muscles of its body-cavity are highly developed, for there are more than twenty pairs with quite definite functions. In the limbs there are two pairs of dorsoventral fibres; the muscles of the foot are so disposed as to serve for the attachment and fixation of the suctorial apparatus.

The nervous system consists of a brain lying in front of, and partly on the pharynx, of connected periencephalic ganglia and ganglionic cells, as well as peripheral nerves which are connected with ganglionic cells, muscles, and sensory cells. At the hinder end of the brain is a multicellular ganglion, provided with lateral nerve-fibres; there are ganglia connected with one another, and connecting the brain with a large subœsophageal ganglion. From the two dorsal periencephalic ganglia there arise two dorsal fine nerves which pass to the ganglionic cells on the mid- and hindgut. At the anterior end of the œsophagus there is a unicellular ganglion which sends off fibres anteriorly to the proboscis, laterally to a muscle, and posteriorly to the subœsophageal ganglion. The tactile organ has but one joint, at the end of which are a few stiff setæ; at its base there is a multicellular ganglion, which is connected with the ganglion of the proboscis, and gives off nerves to the cells between the œsophagus and the wheel-organ. The proboscis is also an active organ

* Reports on the Voyage of H.M.S. 'Challenger,' liv. (1887) 150 pp., 16 pls.
† See this Journal, 1887, p. 754. ‡ Zool. Anzeig., x. (1887) pp. 465–8.

of touch, and is well provided with nerves. The tip of the wheel-organ is not a syncytium, but is composed of several parts. The pharynx is spherical, and surrounded by five large ventral, and several smaller lateral salivary glands. These salivary glands are connected with the œsophagus.

The two excretory tubes open into the rectum without any contractile vesicle; no ciliated infundibula were observed. The eggs develope in the cœlom.

The author believes that the bilobed wheel-organ of the Philodinidæ may be referred to the ciliary circlet of the trochosphere, that the proboscis is the homologue of the anterior end and a part of the frontal plate of the trochophore, and that the brain of Rotifers is partly formed by the frontal plate, and partly by the connection with it of primitively peripheral ganglion cells.

Echinodermata.

Histology of Echinoderms.*—Dr. O. Hamann deals in this essay with the regular Echinoidea and Spatangida. He accepts Valentin's fourfold classification of the pedicellariæ, which he calls gemmiformes, tridactyli, ophiocephali, and trifoliatæ. The first of these are described in *Sphærechinus granularis* and *Echinus acutus*. A careful description is given of their musculature and nerve-supply. The glands which are found on the stalks agree in structure with the globiferæ, and, as in them, stimulation produces a flow of finely granular mucus, which coagulates at once in either water or alcohol. The gland-cells are irregular, and their oval nuclei are surrounded by only a small quantity of cell-substance. Below the basal membrane there is a layer of concentrically disposed smooth muscular fibres, by the contraction of which the secretion is evacuated. The connective substance in which the glands are imbedded is very poorly developed. The orifice of the gland is dorsal to the calcareous tip of the pedicellaria.

The tridactyle pedicellariæ, which were found in all the Echinids examined, are described in *Centrostephanus longispinus* and *Dorocidaris papillata*. In the latter, one form is remarkable for the possession of glandular tubes on the branches. These tubes are quite different in form from those of the gemmæform pedicellariæ. A few short tubes hang together in a racemose fashion, and open into a long efferent duct; they are set in the connective tissue, and their epithelium consists of finely granular flattened cells, which pour their secretion into the narrow lumen of each tube. These peculiar pedicellariæ are principally to be found on the oral membrane. The buccal pedicellariæ are the simplest of the trifoliate type, having neither glands nor special sensory organs.

In discussing the mechanism of the movements of the mobile terminations of the pedicellariæ, investigators appear to have confined their attention to the three adductor muscles, and have been content to explain the separation of the arms by the elasticity of the parts. Dr. Hamann has discovered extensor muscles which are inserted into the same calcareous pieces as the adductors, but on the outer surface, and nearer the base of the calcareous plates. As to the functions of these organs, which have been so much discussed, it appears to be necessary to distinguish between the various kinds. Their numerous nerve-endings seem

* Jenaisch. Zeitschr. f. Naturwiss., xxi. (1887) pp. 87–266 (13 pls.).

to show that they are tactile organs. The smallest, such as the trifoliate pedicellariæ, have certainly the action of scavengers and cleaners; the larger, such as the tridactyles, serve principally to ward off larger living bodies, and also to hold on to fixed foreign objects during locomotion. The gemmæform pedicellariæ also have this function, and their seizing power is aided by the secretion of the glandular sacs.

The author next deals with the globiferi of *Centrostephanus longispinus*, of which two kinds are described. Some are compressed, and have an exceedingly short stalk, while others are more delicate, and have a longer stalk. Each consists of three spheres, which are closely appressed and fused at their points of contact. The glandular contents are of a yellowish colour. In the centre of the stalk there is a calcareous rod, which has generally a spherical termination, and above it the integument forms a sort of hood.

As to the minute structure of the globiferi, the author states that the investing epithelium consists of cubical cells, among which are a large number of yellow pigment cells. The interior of each oviform gland is occupied by long cylindrical palisade-like cells, which have but a narrow central space. If a living globifer be compressed, the cells may be seen to suddenly pass out by the orifice of the glands. The cell may be shown to have been broken off above the nucleus. The examination of sections demonstrates that the glandular contents consist of a mucous mass, with an investment of cells along the wall. The latter are surrounded by a small quantity of protoplasm, and do not appear to have definite boundaries. Their nuclei are of some size, and nearly always contain some distinct nucleoli. Among them there are scattered smaller cell-nuclei.

The globiferi can be best made out in *Sphærechinus granularis*, where they were first observed by the author.* The fact that these organs have hitherto escaped detection is doubtless explicable by their superficial resemblance to pedicellariæ, from which, indeed, they appear to have been derived.

The spines are next discussed, those of *Dorocidaris papillata* being first described. All but the large thick spines present an arrangement which has not yet been detected in any Urchin. At the base there is a mass of large glandular cells. The thickening at the base is due to the thickening of the connective substance and the superjacent epithelium. The latter is made up of ordinary epithelial cells and of glandular cells. The latter are tubular, and are surrounded by a membrane. The cell itself consists of a granular, highly refractive mass, and a large number of cilia project from its free ends. The epithelial cells are fine and filamentar, and the base is connected with nerve-fibres. Nerve-trunks can be made out in each spine, and these can be traced to the nearest ambulacral nerve. In *Sphærechinus granularis* there is a basal nerve-ring, whence nerve-fibres pass to the longitudinal muscular fibres, and the capsule of connective substance. Above the ring the superficial epithelium is much thickened, and the cylindrical cells, which are long and hair-like, carry long cilia at their free ends. Below the epithelium is the muscular layer, formed of longitudinal smooth fibres, which have their origin in the upper calcareous piece of the spine, and are inserted into the calcareous pieces of the body-wall at the base.

The last kind described are the rotating dorsal spines of *Centrostephanus*

* See this Journal, 1886, p. 452.

longispinus, which are placed round the arms, and which during life may be seen to be continually moving, their tips describing a circle. These spines are from 1–3 mm. in length, according to the size of the animal. On the surface there are a number of sensory prominences. Like the other spines, these are attached to a hemispherical tubercle. Around their base is a nerve-ring, whence fibres pass to the subjacent musculature and to the tip of the spine. There is a rich muscular supply, which is cylindrical in form, and is made up of transversely striated fibres. This transverse striation is very rarely to be detected in specimens which have been preserved in alcohol.

The nervous system of a few Echinids was examined, and an elaborate account is given. Nerve-fibres are to be found throughout the epidermis, whence they pass into the cutis. At the middle of the paired ambulacral plates are longitudinal canals. These begin at the apical pole beneath the fine intergenital plates, and extend to the masticatory apparatus. They are formed from the schizocœl, and lie in the layer of connective tissue. Here, too, are the five radial nerve-trunks which, in the Asteroidea, lie in the ectoderm. The trunks consist of very fine nerve-fibres and ganglionic cells, together with a cellular investment, which is partly formed of supporting cells. This epithelium may be regarded as the homologue of the epithelium of the ambulacral grooves of star-fishes, for it is not only the nervous mass, but also the whole epithelium that has come to lie in the mesoderm, as in Holothurians. From the nerve-ring branches are given off to the œsophagus, which extend over the whole of the enteric tract.

The blood-carrying spaces consist of fine longitudinal canals and a circular space surrounding the nerve-ring. These structures in Echinids have nothing to do with the true blood-lacunæ, which arise from the blood-lacuna-ring, which lies on the surface of the "lantern," as a ventral and dorsal enteric lacuna. From the dorsal lacuna branches are given off, which surround the glandular organ (or "heart" of earlier authors). In its terminal portion the lacunæ of the anal blood-lacuna-ring are brought into connection with this organ. The anal lacuna passes into a circular schizocœl-sinus, which surrounds the anus; from it blood-lacunæ are given to the generative organs.

Dr. Hamann describes a canal from the water-vascular ring as passing into the "Polian vesicles"; the canal opens into their cavity while blood-fluid circulates in lacunæ in the wall of connective tissue, and these lacunæ are in direct connection with the blood-lacuna-ring.

In the Spatangida the five longitudinal canals and an œsophageal sinus communicating with them are present; the true blood-lacuna-ring has, however, disappeared with the lantern, and the dorsal and ventral enteric lacunæ open into the sinus. The dorsal lacuna runs beside an enteric vessel, which arises from the circular canal that surrounds the mouth. Later on, this water-vessel and the enteric lacuna communicate with one another, and extend as far as the true stone-canal. In this way a connection is effected between the water-vascular and blood-lacuna-systems—or, in other words, between spaces of endodermal and schizocœlic origin—such as has not been observed in any other group of Echinoderms. We may well suppose that this arrangement is secondary, since the Spatangida are palæontologically the youngest form.

The ovoid gland or so-called heart is a remarkable organ; so far as

we can judge at present it may be regarded as an organ in which the materials which are of no further use to the body are stored up. Blood-lacunæ open into it at its ends and surround it as in regular Echinids, but an efferent duct from it has not yet been detected in any form.

The mode of origin of the genital products is particularly interesting. The primordial germ-cells lie in a circular genital tube from which arise five saccular outgrowths, into which the germ-cells wander; these outgrowths form the first rudiments of the generative tubes, and the cells not only form the male or female elements, but the general epithelium which, later on, invests the cavities of the generative organs. In the adult these tubes atrophy.

Dr. Hamann believes that those naturalists take the most correct view of the phylogeny of the Echinodermata, who regard the Asterida as being the most ancient members of the phylum. He discusses in detail the evidence as to the origin of Echinids from Asterids.

Asterids have five or more radial (ambulacral) longitudinal canals in the ventral walls of the arm, and an oral circular canal; in regular Echinids these are present, as the neural canals; in Spatangids the oral ring becomes connected with the enteric lacunæ, as it does also in Crinoids and Holothurians. Asterids have blood-lacunæ and an oral blood-lacuna-ring in the septa of the longitudinal canals, but these are wanting in the other groups. Asterids have blood-lacunæ in the septa of the dorsal schizocœl spaces at the apical pole, which are present in all Echinoids, placed partly in the arms of Crinoids, and wanting in Holothurians.

Wandering Primordial Germ-cells in Echinoderms.*—Dr. O. Hamann here deals with a question which he did not fully treat of in his essay on the Histology of Echinoderms (see above). He finds that the primordial germ-cells appear very soon after the larval stages are passed; they are present in star-fishes and Urchins 0·5 cm. in diameter. The egg-cell and sperm-cell of all Echinoderms arise from one and the same element of the primordial germ-cell. The canals or genital tubes are placed in Crinoids in the arms, in Ophiurids partly in the dorsal wall and partly in the walls of the bursæ, and in Asterids and Echinids in the dorsal walls of the disc. They lie in a septum of connective tissue, in the meshes of which are blood-lacunæ; the septum is always found in schizocœlic spaces. The contents of the tubes are, in all cases, cells about 0·008 to 0·01 mm. in size, which exhibit amœboid movements, and have but a small quantity of cell-substance which can be stained. The nucleus is from 0·005 to 0·007 mm. in size, and forms a clear vesicle, in which a well-developed plexus, which ordinarily stains very deeply with carmine, can be made out. In Crinoids the primordial germ-cells come to maturity in the pinnules, which are lateral outgrowths of the genital tubes; in the Ophiurids they pass into the walls of the bursæ which are invaginations of the ventral body-wall. In Asterids and Echinids the outgrowths form racemose organs; the Holothurians probably resemble the Echinids, and in both the adult has no remnants of the tubes.

The author calls attention to the resemblance between Echinoderms and Hydroid Medusæ; in both there is a migration of primordial germ-

* Zeitschr. f. Wiss. Zool., xlvi. (1887) pp. 80–98 (1 pl.).

cells to definite maturation-centres; but the resemblance is not complete, inasmuch as the cells in the polyp are already differentiated into generative cells when they begin to wander, while in Echinoderms the differentiation is effected after the migration.

True Nature of the Madreporic System of Echinodermata.*—Prof. M. M. Hartog comes to the conclusion that the madreporic system of Echinoderms is morphologically and ontogenetically a (left) nephridium. He has found by experiments that its ciliary current is directed outwards through the madreporite, and that in *Comatula* an outward current takes place through the pores of the disc. As against the theory that the system serves for taking in water, the author urges that there is no need for this since osmosis is amply sufficient for the turgescence of dilatable organs. The rapid contraction or erection of the tube-foot is due to the transference of liquid from one part to another. The change of position of the madreporite in most Holothurians is, it is suggested, probably due to the usurpation of nephridial functions by the respiratory tubes which are connected with the cloaca.

The author takes the opportunity of remarking that it is very probable that, when an Actinian is at rest, the oral slit is completely closed; turgescence of the body is effected by osmosis, and the apical pores of the tentacles would appear to have the double function of the periodical or perhaps constant discharge in small quantities of the excess of liquid, and of its rapid discharge when, in defence, the animal wishes rapidly to reduce its bulk.

Nervous System and Vascular Apparatus of Ophiurids.†—M. S. Cuénot has examined the nerve-trunks of Ophiurids after treatment with osmic acid and distilled water, and finds that they are formed of an epithelium of elongated cells, among the bases of which very fine nerve-fibrils run. The epithelial nuclei are all placed above the fibrils, and it is they which were taken by MM. Teuscher and Koehler for nerve-cells. The histological characters of the nerve-trunks of Ophiurids are, then, exactly the same as those of Asterids. The nervous ring, in addition to the ambulacral nerves, gives off two branches in each interradius; the more external of these goes directly to the large external interradial muscle, and the other, which is larger, gives branches to the dental papillæ. In the Ophiurids which were examined the œsophagus was found to be directly continuous with the nerve-ring by a delicate membrane in which nuclei are scattered; in Asterids the two are in more obvious connection. In the Euryalidæ the œsophagus receives numerous nerves, united into a plexus, which becomes united with the nerve-ring.

Branches from the radial nerves penetrate the ossicles of the arm and terminate in the intervertebral muscles, which are the active agents in locomotion. The branches distributed to each spine have each a small swelling formed by nerve-cells or fibres; they extend some way along the axis of the spine, and then become lost in its substance.

The circular and radial vessels which MM. Ludwig and Koehler have called the vascular system are only connective-cells and fibres, and have no morphological value. There is a supraneural sinus (the perihæmal of Ludwig and Koehler), within this a nerve-trunk, then a vascular

* Ann. and Mag. Nat. Hist., xx. (1887) pp. 321–6.
† Comptes Rendus, cv. (1887) pp. 818–20.

sinus (perihæmal of Ludwig and Koehler, to which alone the term is applicable), and then the ambulacral canal. The vascular ring is connected to the aboral by a sinus which incloses the ovoid gland and the sand-canal; the aboral ring gives off the genital vessels which form a blood-sinus around the genital cæca; in the interior of the aboral ring and its appendages there is, as in Asterids, a genital cord, at the expense of which the genital organs are formed; this, in the adult, becomes fused with the base of each genital organ. It incloses a certain number of nuclei and of cells which are similar to those of the ovoid gland; in addition there are cells of large size, with a large nucleolated nucleus, which are identical with young ova and the mother-cells of spermatozoa; where the genital cord is in contact with the genital cæca the cord is composed solely of these cells.

The lymphatic glands are, partly, the Polian vesicles for the ambulacral apparatus, as in Asterids and Holothurians, partly the ovoid gland for the vascular apparatus and general cavity, and, partly, the small glands which are placed at the outer extremity of the respiratory cleft; the products of these last are probably destined for the genital vascular apparatus.

Development of Apical Plates in Amphiura squamata.*—Dr. P. H. Carpenter takes as his text Mr. J. W. Fewkes's recent observations on the development of the calcareous plates of *Amphiura squamata*. He urges that the radial plates are mutually homologous in Ophiurids and Urchins, Asterids and Crinoids, and that the relative time of their appearance is of no general morphological importance. As against Fewkes's view that the radial shields of *Amphiura* are the homologues of the first brachials of a Crinoid, three objections are raised. Many Crinoids have no paired first brachials, for they have only five arms; the only genera in which the paired first brachials rest directly on the primary radials are the aberrant *Allagecrinus* and *Tribachiocrinus*, but this is not the case all round the cup; the radial shields are often separated from the primaries by a series of intermediate plates, which exhibit no general constancy of arrangement. Dr. Carpenter would prefer to regard the radial shields of Ophiurids as being, like the terminals of both Ophiurids and Asterids, without representatives in the Crinoidea.

In defence of his homologization of certain intraradial plates in *Amphiura* with the basals of Crinoids the author points out that the plates in question have an interradial position within the ring of radials, and are at one stage of development the only adaxial interradial plates; so that they correspond exactly to the basals of monocyclic Crinoids and to the so-called genitals of Urchins and Asterids.

Attention is particularly directed to the considerable difference in the order of formation of the principal apical plates in the American and European varieties of the same species; though this does not seem to have attracted the special notice of Mr. Fewkes, it bears very strongly on any argument as to homology which can be extracted from differences in the time of appearance of plates.

Calcareous Corpuscles of Holothurians.†—M. E. Hérouard has examined the calcareous deposits of a number of dendrochirotous Holo-

* Quart. Journ. Micr. Sci., xxviii. (1887) pp. 303-17.
† Comptes Rendus, cv. (1887) pp. 875-6.

thurians. He finds that the basis of each is a group of hexagonal prismatic cells, arranged in a single layer. Four adjacent cells serve as the centre of attraction for the calcareous molecules, and give rise to an X-shaped corpuscle. The calcareous deposit next attacks the other lateral walls of the four cells, but the bases of these always remain free from any deposit; the centre of each cell is occupied by the nucleus, the presence of which explains the holes in these bodies. As the deposit is most abundant along the crests of the hexagonal cells, the surface of the corpuscle becomes ridged. These four cells the author proposes to call the four fundamental cells of the corpuscle, and he applies the term of fundamental calcareous corpuscle to the body which arises by the calcification of the lateral walls of these four cells. This fundamental form is common to all the species; the differences seen in various forms are due to the mode of calcification of the surrounding cells.

Cœlenterata.

Morphology of Siphonophora.*—In continuation † of his studies on this subject, Prof. C. Chun describes the post-embryonic development of *Physalia*. He has been able to undertake this investigation thanks to the collections made on board the 'Vittore Pisani,' and he has been fortunate enough to find specimens which connect the larvæ described in 1858 by Huxley with adult forms. In a larva of 5 mm. it was seen that the lower third of the air-sac is converted by a circular constriction into an air-funnel; the polymorphous appendages of the trunk are distinctly differentiated into two groups, one larger than the other. There was no indication of the crest. In the later stages the air-sac was more extensive, the crest developed, and the appendages increased in number. The air-sac traverses the cavity of the enlarged trunk in an oblique direction, and in such a way that the funnel approaches, near the anterior larger group of appendages, the wall of the body, where it flattens out into a sharply circumscribed plate. This "air-plate" consists of a single layer of ectodermal cylindrical epithelium, which passes at the margin into the flattened epithelium of the inner wall of the air-sac. This, though it has escaped the notice of all observers, grows to a considerable size, and is homologous with the secondary ectoderm in the pneumatophore of the Physophoridæ; like it, it is the organ for the secretion of the gas contained in the air-sac; the great development of the secondary ectoderm explains the rapid renewal of the air in the bladder.

The recognition of a structure homologous to the air-funnel makes it possible to understand the pneumatophore of *Physalia* in all stages of development. A line drawn from the centre of the air-plate through the pore corresponds to the primary axis of the pneumatophore of the Physophoridæ; the asymmetry of the bladder of *Physalia* becomes marked very early.

The structure of the crest is more complicated than has been hitherto supposed; there is a longitudinal septum which divides it into two halves; with this tile-like septa become connected, which arise from its free edge and overlie the transverse septa of the first and second order, and extend as far as the air-umbrella. Notwithstanding the great development of its musculature, by means of which the living

* Zool. Anzeig., x. (1887) pp. 557-61, 574-7. † See this Journal, 1887, p. 970.

animal is capable of making the most various changes in the form of its body, it may be referred to the arrangement general among Pneumatophora.

The supporting lamella of the air-umbrella gradually widens out and forms a considerable layer, which in section is seen to be concentrically striated; it is clearly secreted by ectoderm cells. The pneumatophore early takes on its characteristic triangular form, which is especially distinct throughout life in *P. utriculus*. Various parts of the author's description will be more easily comprehended when they appear in the promised illustrated memoir.

Influence of Salinity.*—Herr C. F. W. Krukenberg has made an elaborate series of experiments on the relation of the salt content of Medusæ to the salinity of the surrounding water. (1) The fluid in the disc always closely corresponds in salinity to the surrounding water; in waters with less salt, however, the salinity of the disc bears a much greater proportion to that of the water than occurs in the Medusæ of salter seas. (2) From the examination of seven different forms of Medusa, it was seen that in regard to the salinity of the water leaving the disc no noteworthy differences obtained. (3) There is no evidence to suggest that the salinity of the disc in salt seas can sink below that of the surrounding water without danger to life. The study of Red Sea forms showed on the contrary that as long as the external salinity does not exercise any injurious influence on the life of the organism the internal salinity is always greater than that of the water.

Krukenberg has made a very extensive series of experiments, of which the tabulated results are given, on the loss of water when the Medusæ are removed from their medium, and on the influence of numerous reagents. (1) The loss of water, which takes place by a special process, occurs much more rapidly in air than in sea or distilled water. (2) It is much more rapid in the first hours of exposure to dry air. (3) The loss, especially at first, is greater in distilled than in sea-water. The influence of numerous reagents on the loss of water is then chronicled.

Finally, the author sums up all the various ways in which water may pass into or out of an organism, and inquires how it passes out in Medusæ. He regards it as quite certain that diffusion has nothing to do with the process. The water passes in by absorption, but Krukenberg is unable to decide whether it passes out by exudation or in a purely mechanical fashion, or by both combined.

Colours of Corals.†—Dr. C. F. W. Krukenberg has made a study of the colours of the living corals in the Red Sea. It is well known that the coral banks afford a feast of colour hardly to be surpassed by any other of nature's displays. The species which he investigated were *Stylophora subseriata* Ehrbg., *Pocillopora hemprichi* Ehrbg., *Seriatopora spinosa* M. E. and H., *Madrepora haimei* M. E. and H., *Favia ehrenbergi* Klz., *Galaxea irregularis* M. E. and H., *Montipora tuberosa* Klz., *Turbinaria conica* Klz., and *Tubipora hemprichi* Ehrbg.

In these species Krukenberg found the following pigments:—(1) the yellowish-brown colouring matter of the so called "yellow cells" of the Actinidæ, which exhibits a deceptive resemblance to the hepatochrome

* Vergl. Physiol. Studien, II. Reihe, 4 Abth. (1887) pp. 1–58.
† Ibid., pp. 172–87 (1 pl.).

(MacMunn's enterochlorophyll) of higher Invertebrates; (2) Anthea-green; (3) rose and purple-red Floridine; (4) a (yellow) Uranidine; (4) chlorophane- and rhodophane-like lipochromes, but in small quantity as in *Anemonia;* (6) a red lipochromoid which is not readily dissolved out.

The extraction and examination of the different pigments are described, and a spectrum table is appended. The colouring matter of the yellow cells of *Anemonia* is constantly to be found in stone corals. The most abundant associated pigment is a yellow uranidine which entirely resembles aplysinofulvine. Floridine, which is common in sponges, is also very frequent among corals. The persistent red of the noble coral (*Corallum rubrum*), and of the organ-pipe coral (*Tubipora musica*) resembles that of many mollusc shells, and consists of a rhodophane pigment combined with the lime.

Nervous Tracts in Alcyonids.*—Dr. C. F. W. Krukenberg has investigated the nervous physiology of *Xenia* in order to elucidate the relations of dependence between the individual polyps and the colony. Something has already been done in this direction with Polyzoan colonies, but hardly anything has yet been achieved with Alcyonids.

By a series of experiments the following facts were established in regard to individual polyps:—(1) conducting nervous strands penetrate the entire body of the polyp, on the sides of the wall as on the basal plate, both in the oral disc and in the tentacles; (2) stimuli from one half of the body to the other pass more readily viâ the oral disc than by means of the strands in the basal plate; (3) stimuli pass more readily from the base to the mouth-disc than in the opposite direction.

In regard to the more difficult problem of the relation of the individuals to the general colony, Krukenberg draws the following conclusions from his experiments:—(1) All portions of the *Xenia* colony are provided with contractile tissue. The contractions are directly under the influence of a ganglionic network, which is somewhat superficially spread out in the branches, the stem, and the foot-plate. (2) The ganglionic network is much more sparsely developed in that portion of the colony which simply supports (the branches, the stem, and the foot-plate) than in the oral disc and tentacles of the polyps. Its influence is especially marked in the stem on such portions as underlie the branches, where there must be larger aggregates of ganglia. This fact seems to explain why influences take effect almost exclusively above the point of irritation, and not backwards from it. (3) Stimulation of a point on the stem is much more readily propagated in the transverse than in the basal direction. Hence may be inferred the existence of cross anastomoses in the ganglionic network. The relations are very lucidly displayed in a diagrammatic figure.

Finally, the author devotes some space to a criticism of certain researches of Keller on the contractions of *Xenia*. The gist of these observations lay in the conclusion that on the peristome, probably on the margin and near the base of the tentacles, motor centres were present which occasioned rhythmic contractions. With the same species (*Xenia fuscescens*), and at the same locality (Suakim), Krukenberg was quite unable to observe the rhythmic contractions which Keller even

* Vergl. Physiol. Studien, II. Reihe, 4 Abth. (1887) pp. 59–76 (1 pl.).

counted. He suggests that the abundant suspended particles in the canal-water of Suakim caused the contractions which Keller regarded as rhythmic. On experimental and histological grounds Krukenberg regards their existence as very improbable.

Porifera.

Sponges.*—Prof. W. J. Sollas has a well-illustrated general article on Sponges. In the account of structure and form he commences with a description of *Ascetta primordialis*, as a simple sponge; the various modifications undergone by the canal-system are next described, in connection with which the term of prosopyle is applied to the pores which lead directly into the radial tubes or paragastric cavity. In the skeleton, megascleres or skeletal, and microscleres or flesh, spicules are distinguished; the modifications of these are described, considerable additions being made to the terminology of the skeletal constituents.

In the account of the histology of the mesoderm various kinds of cells are distinguished; the stellate connective-tissue corpuscles are called collencytes, and the tissue collenchyme. Cystenchyme consists of closely adjacent large oval cells, and is particularly found in certain Tetractinellids. Long fusiform connective-tissue cells are called desmacytes; they often form the greater part of the cortex of a sponge. In all higher forms contractile fibre-cells or myocytes are to be found, and there appears to be more than one kind of them. The supposed sense-cells are called æsthacytes.

With regard to protoplasmic continuity, Prof. Sollas says, "In most sponges a direct connection can be traced by means of their branching processes between the collencytes of the mesoderm and the cells of the ectodermal and endodermal epithelium and the choanocytes of the flagellated chambers. As the collencytes are also united among themselves, they place the various constituents of the sponge in true protoplasmic continuity. Hence we may with considerable probability regard the collencytes as furnishing a means for the transmission of impulses; in other words, we may attribute to them a rudimentary nervous function."

The extraordinary profusion of sponge-spicules in some modern marine deposits and in the ancient stratified rocks is accounted for by the fact that the sponge is constantly producing and disengaging spicules. Each spicule originates in a single cell or scleroblast.

The phylum Parazoa or Spongiæ is thus divided:—

Branch A. Megamastictora.	Branch B. Micromastictora.
Class. Calcarea.	Class I. Myxospongiæ.
	„ II. Silicispongiæ.
	Sub-class i. Hexactinellida.
	„ ii. Demospongiæ.
	Tribe *a*. Monaxonida.
	„ *b*. Tetractinellida.

A sufficiently detailed systematic classification is given.

The asexual and sexual modes of reproduction are described, and a notice is given of the two chief types of development; one, which is common among the calcareous sponges, is characterized by the "amphiblastula," and the other by the "planula" stage.

A short account is given of the little that is known as to the physiology

* Encycl. Brit., xxii. (1887) pp. 412–29.

of sponges, and of their distribution, as to which our information is very fragmentary. After a selected list of works treating on sponges, Prof. Sollas gives an account of the mode of taking, cultivation, and preparation for market of officinal sponges.

Skeleton of Calcareous Sponges.*—Prof. V. v. Ebner has submitted the spicular skeleton of calcareous sponges to a searching analysis, and comes to the conclusion that the spicules are always "bio-crystals." "The spicules are mixed crystals, mainly composed of calc-spar, containing no organic material; the outer form is without the true crystalline contour, but is determined by the specific activity of the organism; the internal structure, though perfectly crystalline, stands in relation to the external form by a peculiar distribution of the mixed ingredients." The mixture of salts is due to contemporaneous excretion of more than one. More briefly he reviews the skeleton of calcareous Algæ, Foraminifera, Cœlenterates, and Echinoderms, in which marked differences, and at the same time, striking resemblances occur. "In the formation of bio-crystals the crystallographic orientation of the substance first excreted is alone determinative, and all the rest of the substance is formed on the above foundation according to the laws of crystallization, without special activity of the protoplasm, which has only a moulding influence on the external form and on the mixture of material. When, however, organic material is excreted along with the calc-spar, as in the calcareous membranes of corallines and spicules of corals, there is no longer a uniform crystallization." It is still a crystalline excretion, but the molecules of carbonate of lime arrange themselves in a fashion "in general like that found in non-calcified, doubly-refractive tissues."

New System of Chalininæ.†—Mr. A. Dendy has some criticisms on a recent publication by Dr. R. von Lendenfeld dealing with the Chalininæ of the Australian region. He points out that the generalization that there are no incrusting Chalinids is contradicted by Dr. Lendenfeld's definition of his new species *Hoplochalina incrustans*. There are some important divergences between the letterpress describing, and the figures illustrating the canal-system, the latter giving representations of certain remarkable funnel-shaped canaliculi, such as neither Mr. Dendy nor any other author has yet found in a Chalinid sponge.

The systematic classification of the Chalininæ is severely dealt with, and evidence is afforded of Dr. von Lendenfeld having adopted in the main the classification of Messrs. Ridley and Dendy, "but instead of giving it in the way we gave it, and with the significance which we attached to the different groups, he has modified it to suit his present purposes, thereby, in my opinion, almost entirely destroying its value." Spicules, it is urged, not spongin, must be taken as guides to classification.

Fresh-water Sponges.‡—Mr. E. Potts has published a synopsis of the known American forms of fresh-water sponges, with descriptions of those named by other authors, &c., from all parts of the world. After a general account of their structure, and of the means of collecting, observing, and mounting them, the author justifies his method of nomenclature.

From imperfect memoranda Mr. Potts finds that he has examined

* SB. Akad. Wiss. Wien, xcv. (1887) pp. 55-148 (4 pls.).
† Ann. and Mag. Nat. Hist., xx. (1887) pp. 326-37.
‡ Proc. Acad. Nat. Sci. Philad., 1887, pp. 158-279 (8 pls.).

Spongilla fragilis from at least thirty-two localities in eighteen North American States, *S. lacustris* from twenty-six localities in sixteen States, and *Meyenia fluviatilis* from twenty-five localities in fourteen States. Hardly any two specimens are exactly alike in their so-called typical features, but all may be grouped, and common definitions or descriptions will, without undue elasticity, cover them all.

A diagnosis of the European Spongillidæ, translated from the Bohemian text of Prof. Vejdovsky, follows, and this is succeeded by a synopsis of Mr. Carter's classification. Then comes a key to the species of *Spongilla*, and descriptions of the species, those that are American being treated with more detail than the rest. The genera *Meyenia*, *Heteromeyenia*, *Tubella*, *Parmula*, *Carterius*, *Uruguaya*, *Potamolepis*, and *Lubomirskia* (?) are treated in the same way, so that a valuable compendium is produced.

In conclusion the author says, "Some points . . . . worthy of the thought and study of future students have already been suggested, such as the *necessity* of gemmules in fresh water as distinguished from marine sponges; the process of their formation; their functions, and the means by which that end is attained; the law of variation in the quantity and character of the enveloping crust; and the time and mode of formation of the imbedded armature—all have yet to be conclusively studied. Other questions of a more limited character occur in the search for the line of derivation that must be supposed to run through all the genera and species; and in the association, apparently indicated amongst otherwise dissimilar species, by the presence in them of correspondent forms, such as the birotulate dermals found in certain *Spongillæ* and *Meyeniæ*, and the more frequent recurrence in several genera of acerate dermals with characteristic, centrally located, perpendicular spines, &c."

Development of Generative Products in Spongilla.*—Herr K. Fiedler argues, against Prof. Goette, the unicellularity of the ovum of *Spongilla*. He has always found distinct cell-boundaries in the egg-cell, and only one nucleus. Double coloration with picrocarmine and "bleu de Lyon," with quick washing of the sections with slightly ammoniacal alcohol, gives a bright red colour to the nucleus, and colours blue even the smallest parts of the yolk. The author finds that the large round vitelline spheres do not, as Goette imagines, appear first, but that they are preceded by all possible stages of smaller yolk elements. The follicular cells are regarded as parenchymatous cells which have been flattened out by the pressure of the growing egg. Some of them appear to be special nutrient cells, and often their amœboid processes may be seen pushing themselves between the ordinary follicular cells towards the egg, without, however, fusing with it. They prepare in their interior material which is to be regarded as preparatory to yolk-stuff, and which is given up to the egg by diffusion.

In addition to these, there are certain amœboid wandering cells of another kind, the body of which is quite regularly filled by rather large particles. They correspond to those described in the Calcarea by Polejaeff. They are scattered through the whole body of the sponge, but are especially numerous below and among the cells of the cortex, and more particularly near the afferent orifices. They have probably a nutrient function.

* Zool. Anzeig., x. (1887) pp. 631–6.

The growing egg becomes more and more filled by yolk-granules, but the nucleus never disappears completely, though it often approaches the surface. This position is, no doubt, to be correlated with the extrusion of the polar globules.

Spermatogenesis is on the second type of Polejaeff. There is no special covering-cell or primitive sperm-cell. In division, karyokinesis was frequently observed.

Protozoa.

Conjugation of Paramæcium.*—M. E. Maupas finds that the conjugation of male and female pronucleus as previously described by him was admirably figured by Balbiani in 1858.† Maupas had known the compressed summary in the Comptes Rendus, but not the full research with plates. Balbiani figured the process beautifully, but regarded what he figured as the longitudinal division of the micro-nuclear (nucleolar) element. At this time only Warneck, in another overlooked research (1850), had observed the conjugation of pronuclei in the ova of *Lymnæus*. This was reobserved in 1874 by Bütschli in a nematode.

The phenomena described by Maupas have now been observed in nine ciliated Infusorians: *Paramæcium caudatum*, *P. aurelia*, *Stylonichia pustulata*, *Onychodromus grandis*, *Spirostomum teres*, *Leucophrys patula*, *Euplotes charon*, *Loxophyllum fasciola*, and *Paramæcium bursaria* (Balbiani).

M. Maupas reaffirms his certitude as to the seven first stages in the complex process. The micro-nucleus increases, divides, eliminates elements, differentiates, elements are exchanged, and two portions (male and female) conjugate. A single nucleus results, and this divides twice. The further reconstitutive changes are less certain. He is, for instance, in doubt as to the persistence of the original nucleus.

New Fresh-Water Infusoria.‡—Dr. A. C. Stokes describes a number of new fresh-water Infusoria. *Hexamita spiralis*, from the intestinal canal of the tadpole of the common toad, differs from previously observed species by the presence of two contractile vacuoles and the spiral disposition of two of the anterior flagella; *Petalomonas dorsalis* which has a conspicuously developed centro-dorsal upright plane, and *P. sulcata* are both from pond water. A new genus, *Urceolopsis*, is established for *Urceolus sabulosus* Stokes; in it the entire cuticular surface is more or less covered by adherent, irregular, and angular sand-grains. *Trachelomonas urceolata*, *T. verrucosa*, and *T. acanthostoma*; *Anisonema solenota*, *Protopteridinium limbatum*, and *Holophrya ornata* follow. *Saprophilus* is a new genus for *S. agitatus* sp. n.; these animalcules are essentially scavengers which, rapidly undergoing fission, swarm in crowds round and within the dead bodies of various small aquatic animals. *Bothriostoma undulans* g. et sp. n., is a heterotrichous form, in which the left-hand border of the peristome carries a series of large cilia, while the posterior portion of the right-hand margin supports an undulating membrane. A second species of *Hymenostoma*, *H. magna* [*um*], is described; it may be easily distinguished from *H. hymenophora* by its larger body; conjugation has been observed, union taking place between the ventral surfaces of the right-hand body margins. There are four new species of *Vorticella*,

* Comptes Rendus, cv. (1887) pp. 955–7. See this Journal, 1887, p. 973.
† Ibid., xlvi. (1858) p. 628, and Journ. de Physiol., i. (1858) p. 347, pl. iv.
‡ Proc. Amer. Phil. Soc., xxiv. (1887) pp. 244–55 (1 pl.).

V. pusilla, *V. mollis*, *V. aqua* [*e*] *dulcis*, and *V. platysoma*. *Opercularia allensi* is about twice as large as *O. nutans*, while the height of its colony is much less; *O. vestita* is also described. *Thuricolopsis* differs from *Thuricola* in that the loricæ have an internal, narrow, flexible, valve-rest, and the zooid is attached posteriorly to the lorica by a distinctly developed pedicle. In this genus are placed *Thuricola innixa* Stokes, and *T. kellicottiana* sp. n. *Platycola cœlochila* and *Lagenophrys patina* are next described. *Histrio erethisticus* is very difficult to study owing to the animalcule having "a most annoying habit of suddenly darting backward for a distance seldom exceeding its own length." Descriptions of *Solenophrya odontophora*, *Acineta bifaria*, *A. macrocaulis*, and *A. acuminata* complete the paper.

Relationships of Foraminifera.* — Herr M. Neumayr divides shelled Foraminifera into three phylogenetic grades; (*a*) the quite irregular and primitive Astrorhizidæ; (*b*) the series with merely agglutinated shells; (*c*) the compactly shelled forms which he believes to have arisen from the former. His classification is thus summarized (in compressed form).

Calcareous grade.	Spirillinids. Perforate. Peneroplis. Miliolinæ. Cornuspira. Imperforate. Cornuspirids.	Chilostomellæ. ? Perforate. Textillarids.	Nummulites. Cycloclypeus. Rotalia. Globigerina. Polystomella. Nodosaria. Perforate. Lituolid.	Fusulina. Perforate. Fusulinella. Imperforate. Fusulinid.
Regular agglutinated grade.	Cornuspirid type. Ammodiscus. Silicina agathamina.	Textillarid type.	Lituolid type, e. g. Lituola Endothyra. Trochammina.	Fusulinid, e. g. Fusulinella p. p. (cf. Endothyra).
Irregular agglutinated grade.	Astrorhizidæ.			

Karyokinesis of Euglypha.†—Herr W. Schewiakoff has made a careful study of the phenomena of division in *Euglypha alveolata*. Division is prefaced by the protrusion of cell-protoplasm and of shell plates from the mouth of the shell. The protrusion as it grows is clad with a new shell, over which for a time the alveolar and granular protoplasm flows. The internal changes begin in the protoplasm of the hyaline zone, which increases in volume, and differentiates into two layers—an outer, denser and reticulate stratum, and an inner clear region round the nucleus.

(1) The nucleus is homogeneous, and not rich in chromatin. (2) The "cyto-chylema" of the clear region penetrates the persistent nuclear membrane, and conditions the increase of the nucleus, which acquires a reticulate structure and more chromatin. The nucleo-hyaloplasm and the fine granules accumulate at the nodes of the net-

* SB. Akad. Wiss. Wien, xcv. (1887) pp. 156–86.
† Morph. Jahrb., xiii. (1887) pp. 193–258 (2 pls.).

work and form coarser meshes. (3) From the meshwork single filaments arise, with irregularly coiled course. The filaments give off small processes, so that their margins appear zigzagged. The granules fuse to form Pfitzner's chromatin spheres, and the filaments finally consist of alternate dark and clear discs.

(4) The filaments become smooth, and are disposed parallel to one another in the peripheral portion of the nucleus. Only a few processes remain connecting the chromatin filaments in the so-called "close coil" (dichte Knäuel). (5) The filaments shorten and thicken to form the "loose coil," and are at the same time bent into sickle shape. The nucleolus now disappears.

(6) The cytoplasm disposes itself radially to the surface of the nucleus. The loops retire inwards, and have their apices directed centrewards. The *sun-form* arises. (7) The cytoplasm of the clear region begins to concentrate at the poles, the nucleus exhibits amœboid movements, the increase in size ceases, the nucleus becomes again spherical. The accumulation of cytoplasm at the poles acquires a rayed structure (the polar rays). The rays converge towards the poles of the nucleus, and meet in a depression. Here arises the polar body, and at the same time appear the spindle nuclear fibres. (8) The nucleus becomes ellipsoid, the loops have their angles on the equatorial plane, the *stellate form* begins.

(9) The spindle-fibres grow from the poles into the nucleus, and unite in the equatorial plane with those from the opposite side. A continuous nuclear spindle is formed, which has a directive influence on the chromatin loops. The nuclear spindle elongates in the direction of the axis of division. The loops become disposed in two ways—the outer remain parallel to the equatorial plane, the inner stand perpendicularly to the same. The star-form is at its climax.

(10) The loops become ribbon-like, and begin to divide longitudinally. The inner loops are bent round to the polar end. The longitudinal division occurs. (11) With re-arrangement the barrel form arises, all the loops lie at right angles to the equatorial plane, their apices are turned to the poles. (12) The loops separate, move polewards, and arrange themselves radially round the somewhat flattened polar body. Thus arise *daughter-stars*, and immediately after (13) the daughter-sun-forms. (14) The nucleus is constricted into two, the protoplasm of the clear zone is also divided, circulation begins in the bodies of the daughter individuals, the plasma of the alveolar and granular zones is divided between the two in approximately equal portions.

(15) Meanwhile the daughter nuclei undergo metamorphosis. The polar body is drawn in, the loops are drawn out into filaments to form the daughter-cells. (16) From the filaments connective threads proceed; a coarse and then a fine network is thus formed, the nucleolus reappears, the nucleus acquires its normal structure. The plasmic circulation ceases, pseudopodia issue from the opening of the cell, the daughter individuals separate.

Changes in nucleus and protoplasm appear contemporaneous. Only the clear zone is active, the rest of the protoplasm passive. Whether the penetration of the cyto-chylema into the nucleus is the very first step or not the author does not venture to decide. The process is clearly one of genuine division, and not, as Gruber maintained, half-way

between division and budding. An interesting phenomenon was sometimes observed, that after the usual protrusion of protoplasm, and after the nucleus had begun to go ahead in its changes, a stoppage occasionally occurred, the nucleus retraced its steps, and everything returned *in statu quo*.

The author concludes by comparing his results with those obtained in other Protozoa, and shows that a considerable manifoldness in the details of indirect division must be allowed to occur.

Diplocystis Schneideri.*—Prof. J. Künstler gives an account of an aberrant Sporozoon which has been found in the body-cavity of *Periplaneta americana*, and which appears to be the representative of a new genus. It is milky white and opaque, and may therefore be easily seen; the adult individuals may be as much as 2 mm. long. The body is spheroidal and monaxial, and has at first sight the appearance of two monocystid Gregarines united by their corresponding extremities; each half has its own membrane, and the whole is surrounded by a general envelope, which extends from one to the other without penetrating into the plane of separation. This membrane is double, but it is probable that the outer of the two has been formed by the host, while the inner corresponds to the cuticle (or epicyte of Schneider's terminology); the inner membrane is fine and transparent. The author is inclined to disagree with Schneider and Bütschli as to the superficial nature of the cuticular striæ of Gregarines, and thinks them to be due to the minute structure of the cuticle. In the new genus the markings are certainly not regular.

Under the cuticle there is a delicate layer of dense protoplasm, which is doubtfully compared with ectoplasm; it is transparent, finely dotted, and scarcely thicker than the cuticle. It entirely surrounds each of the two vesicles of which the body is made up, and forms the septum between them; but, as it is single, and as delicate here as elsewhere, it is clearly not due to fusion, but is the continuation pure and simple of the peripheral layer of the body. The internal protoplasmic mass, which must be regarded as the endoplasm, if the other homologies are correct, is more or less, but never completely, fluid, and is filled with special granulations. When the animal is treated with potash or other reagents which dissolve the granulations, the endoplasm is seen to have a reticular structure. The granules present some of the reactions of amyloid bodies. The structure of the nucleus recalls that of true Gregarines, but a difference from polycystid Gregarines is to be found in the fact that each vesicle has a nucleus or body analogous thereto.

The author gives an account of the formation of the nuclei, and of the development of *Diplocystis;* as to its systematic position, he believes it to be an aberrant type, showing affinities both to the Gregarinida and the Coccidia.

* Tablettes Zoolog., ii. (1887) pp. 25-66 (1 pl.).

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.*

(1) Cell-structure and Protoplasm.

Part taken by the Nucleus in Cell-division.†—Herr E. Zacharias states, as the result of fresh observations, that the cell-protoplasm does not penetrate into the nucleus during its division. The nucleus appears to be always sharply differentiated from the cell-protoplasm when it passes over into the "spindle" condition. Within the mother-nucleus the groups of filament-segments of the daughter-nuclei separate until they reach the poles of the mother-nucleus, and the daughter-nuclei become differentiated from a central part of the mother-nucleus which remains behind between them. Only the framework of the mother-nucleus which contains the nuclein is completely taken up into the daughter-nuclei; a considerable portion of its matrix passes over into the cell-protoplasm. Within the remains of the mother-nucleus the cell-plate is formed out of the cell-protoplasm which penetrates into it; the remains of the mother-nucleus are thus increased in size, and may be separated from the daughter-nuclei on both sides by cell-protoplasm.

Albumen in the Cell-wall.‡—Herr G. Klebs commenting on Krasser's paper on this subject and on Wiesner's previous communications, contests the assertion of the former that alloxan is an unfailing test for substances belonging to the group $CH_2CH(NH_2)CO_2H$. The utmost that can be said is that certain nitrogenous substances are characterized by the alloxan reaction; it is displayed, for example, with glycocoll, and to a less extent with urea and keratinin, as well as with leucin, tyrosin, and other albuminoids. It is also manifested with various inorganic substances, not only with ammonia, but with potassium monophosphate, sodium diphosphate, and the bicarbonates of the alkalies. This test, therefore, in no way proves the presence of albumen in the cell-wall. Herr Klebs further states that if Millon's reagent is to be relied on, it shows the presence of albumen in the walls of wood- and bast-cells, which is incredible.

The author also brings forward arguments in opposition to Krasser's view that the cell-wall is a living organ, comparable to the nucleus or the chlorophyll-bodies. The incorrectness of this view is sufficiently shown by the fact that cells can be parted from their cell-walls, and then have the power to form new ones.

* This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents (including Secretions); (3) Structure of Tissues; and (4) Structure of Organs.

† Versamml. Deutsch. Naturf. u. Aerzte, Wiesbaden, Sept. 21, 1887. Ber. Deutsch. Bot. Gesell., v. (1887) pp. lv.–vi.

‡ Bot. Ztg., xlv. (1887) pp. 697–708. Cf. this Journal, 1887, p. 981.

Thickening of the Cell-walls in the Leaf-stalk of Aralia.*—Sig. P. Pichi describes the mode of thickening of the walls of the liber-cells in the phloem of the fibrovascular bundles in the leaf-stalk of *Aralia trifoliata*. In the early stages the thickening takes place chiefly in the angles, producing a very strong resemblance to collenchymatous tissue. Later, very delicate layers of cellulose are formed within each cell, which become rapidly lignified. Sig. Pichi considers it probable that during the early stages, the thickening takes place chiefly by intussusception, during the later stages by apposition.

(2) Other Cell-contents (including Secretions).

Starch- and Chlorophyll-grains.—M. E. Belzung† has made a series of observations on the morphological and physiological relationship between starch and chlorophyll, which has led him to conclusions differing in several respects from those generally accepted.

In investigating the origin of starch-grains, especially in the ovules of Leguminosæ, M. Belzung finds that, during the formation of the ovule, the embryo, the transitory endosperm, and the integuments, in fact, the entire seed, is the seat of a new-formation of starch unconnected with the previous existence of any leucite or starch-generator; the grains of starch are formed free in the protoplasm by simple crystallization of the amylaceous matter dissolved in the cell. This is true both of accumulations of reserve-starch and of such as is at once used up in the growth of the plant. The theory of Schimper that the leucites are the sole generators of starch is further in opposition to the fact that even when a starch-grain is apparently formed within a leucite, it will continue to grow long after the latter has disappeared. During the development of the transitory starch-grains they undergo a curious metamorphosis. A portion of their substance is consumed, and is used for the production of albuminoids, while the other portion is partially hydrated, and takes the form of a granular skeleton of the same shape, which is coloured yellow or reddish-yellow by iodine reagents. These skeletons are analogous to those obtained by the action of saliva or of dilute acids on the starch-grains in the living plant. They are composed of amylodextrin, and the author proposes for them the term *amylites*. They were found in ripe seeds and in the axis and cotyledons of the lupin. The transitory starch which appears during the germination of seeds is deposited in these amylites, and is formed at their expense. This transitory formation of starch has no connection with the actual assimilation of carbon.

The normal function of transitory starch-grains is to form grains of chlorophyll. The *chloramylite* is the substratum of the future chlorophyll-grain, and the cell-protoplasm takes no part in its formation. Chlorophyll-grains with an amylaceous origin must be carefully distinguished from those with a protoplasmic origin. During the early period of germination chloramylites only are to be found in the stem, to the exclusion of chloroleucites. Reserve-starch-grains exhibit the same phenomena; and they occur in all plants except Fungi, which contain transitory, but no reserve-starch.

* Atti Soc. Tosc. Sci. Nat., viii. (1887) pp. 455–8 (1 pl.).

† Ann. Sci. Nat.—Bot., v. (1887) pp. 179–310 (4 pls.). Cf. this Journal, 1887, p. 423.

In the Florideæ (*Polysiphonia*, *Sphærococcus*,) M. Belzung states that the starch-grains are formed directly in the protoplasm, without the intervention of leucites, and have no definite morphological connection either with the chromatophores or with the nucleus.

The general result of the examination of the embryo of ripe seeds (Leguminosæ) is that they contain no leucites of any kind. A large number of chloroleucites and all chloramylites are formed directly; the former by differentiation of the cell-protoplasm, the latter by metamorphosis of starch-grains. Instead of chlorophyll-grains (chloramylites) producing starch-grains, by the assimilation of carbon, they are themselves formed from starch-grains produced free in the protoplasm. During germination in the dark the transitory starch-grains, after partial absorption, are transformed into amylites. It is these substances, and not the protoplasm, which form the granular substance of the chloramylites.

The formation of transitory starch in fungi in the course of germination was demonstrated in the case of the sclerotia of ergot of rye.

To this M. F. W. Schimper * replies, denying the accuracy of every one of M. Belzung's statements, where they conflict with his own, viz. the statement that it is not proved that starch is formed by leucites, that starch-grains can be transformed, without the assistance of protoplasm, into green granules resembling chloroleucites, but composed of a skeleton of starch impregnated with pigment; and that leucites can be formed free in the protoplasm. The existence of "chloramylites" he considers to be entirely a delusion. The objects recommended for studying the true structure of leucites are the pseudo-bulbs of *Phajus grandifolius*, the rhizomes of *Iris florentina* and *germanica*, and the tubers of the potato.

Quantitative estimation of Chlorophyll.†—By the use of his method already described, Herr A. Tschirch found the usual proportion of chlorophyll in the dry substance of leaves free from ash, determined as phyllocyanic acid, to be from 1·8 to 4·0 per cent.; in a square metre of surface from 0·35 to 1·23 gr. of chlorophyll. The proportion, of course, varied considerably; the most common percentage was 0·8 gr. per square metre.

Formation of Starch in the Chlorophyll-granules.‡—Dr. G. Belluci, in order to determine whether the production of starch under the influence of sunlight, and the subsequent reconversion during night-time, is to be regarded as a physiological or as a chemical change, tried the effect of the presence of various substances. Chloroform, and to a slighter extent ether vapour, destroy chlorophyll, and also prevent the transformation of starch formed during sunlight; carbonic anhydride also diminishes the function of the chlorophyll, but does not destroy it if the action is not allowed to continue unintermittently for twenty-four hours. The saccharification of starch proceeds in the dark, even in cut-off leaves, but more rapidly with free access of air. From these experiments, the author concludes that the phenomenon is a physiological and not a chemical change.

* Ibid., vi. (1887) pp. 77–89.

† Versamml. Deutsch. Naturf. u. Aerzte, Wiesbaden, Sept. 21, 1887. See Bot. Centralbl., xxxii. (1887) p. 57. Cf. this Journal, 1886, p. 346.

‡ Chem. Centr., 1887, p. 572. See Journ. Chem. Soc. Lond., 1887, Abstr., p. 1136.

Inosite.*—Herr R. Fick finds inosite very widely distributed in the vegetable kingdom, in a large number of plants belonging to a great variety of natural orders,—in the seed, seed-vessel, stem, leaves, and roots, though by no means universally. It is present in larger quantities in climbing than in erect plants. The mode of its separation from the living plant in clusters of needles is described in detail.

Tannin in Acanthus spinosus.†—M. J. B. Schnetzler finds tannin present in the leaves of this plant, along the vascular bundles, in the parenchyma of the stem, the peduncles, the walls of the ovary, the ovules, the style, the stigma, and the filaments. He believes it not to be a mere product of excretion, but to play an important part in the life of the plant.

Chemical substances contained in the Box.‡—Besides the three well-known alkaloids of the box, buxine, parabuxine, and buxinidine, Sig. G. A. Barbaglia finds in the leaves two others, to which he gives the names parabuxinidine and buxinamine. The chemical properties of these five alkaloids are given in detail. He finds also, besides Walz's buxoflavina, three distinct pigments, a green, a yellow, and a red, buxoviridinum, buxorubinum, and buxocrocinum. The wax on the upper surface of the leaves he finds to differ from the vegetable waxes previously known, and establishes for it by experiment the composition $C_{30}H_{62}O$.

Aleurone-grains in the Seed of Myristica surinamensis.§—Herr A. Tschirch finds that these seeds are peculiar in the extraordinary development of the albumen crystalloids of the aleurone-grains. Each cell is almost filled with a large crystalloid of the hexagonal system, either a rhombohedron (R) or a combination of the same with the basal plane (R·OR). Twin forms are rare. These crystalloids form the matrix of very large aleurone-grains. As a rule, to each crystalloid is attached a greater or less number of globoids, each including a needle-shaped crystal of calcium oxalate. Besides the globoids, the oxalate crystals, and the protein-crystalloids, the aleurone-grains also contain a residue of amorphous substance. To separate these constituents, a section is freed from oil by means of ether, then very dilute aqueous potash dissolves the albumen crystalloids after washing, acetic acid dissolves the globoids, and then the calcium oxalate is dissolved in dilute hydrochloric acid.

(3) Structure of Tissues.

Laticiferous System of Manihot and Hevea.‖—In addition to the two systems of laticiferous vessels in *Manihot Glaziovii* already described by Dr. D. H. Scott, Miss Agnes Calvert and Mr. L. A. Boodle find a third, in the peripheral portion of the pith, usually in the neighbourhood of a primary xylem-bundle. These laticiferous tubes have reticulate anastomoses similar to those described by Dr. Scott in the cortex.

* Fick, R., 'Unters. üb. d. Darstellung u. d. Eigenschaften des Inosit,' 38 pp., St. Petersburg, 1887. See Bot. Centralbl., xxxii. (1887) p. 133.

† Arch. Sci. Phys. et Nat., xviii. (1887) pp. 300–2.

‡ Atti Soc. Tosc. Sci. Nat., viii. (1887) pp. 255–70.

§ Arch. Pharm., xxv. (1887) pp. 619–23. See Journ. Chem. Soc. Lond.—Abstr., 1887, p. 1061.

‖ Ann. of Bot., i. (1887) pp. 55–62, 75–7 (1 pl.). Cf. this Journal, 1884, p. 409.

In the secondary phloem new laticiferous elements are continually being formed by the cambium. The members of one group branch and anastomose freely among themselves, but do not anastomose with the members of other groups. The cortical tubes form a continuous reticulate cylinder all round the stem. It is probable that at the nodes all the laticiferous systems stand in radial connection with one another. By treating sections of the stem with ether, and staining with hæmatoxylin, numerous nuclei were seen in the laticiferous vessels, both of the phloem and pith; and a protoplasmic layer could also be detected lining the vessels, showing that they retain their living contents after maturity.

In *Hevea brasiliensis*, Miss Agnes Calvert also succeeded in detecting all three systems of laticiferous tissues in older seedlings. In this plant, although the laticiferous tubes consist mainly of vessels formed by the fusion of rows of cells, yet, like the laticiferous cells of other euphorbiaceous plants, they retain the power of independent growth, and may put out branches which grow by their apices. The nuclei are particularly distinct in the laticiferous tubes of all three systems, and may be seen even without staining. They frequently contain very distinct nucleoli.

Tubular Cells of the Fumariaceæ.*—Herr E. Heinricher objects to Zopf's description † of the idioblasts in the tissue of Fumariaceæ as "tannin-receptacles." The contents of these cells consist of a mixture of various substances, and the author prefers for them the designation "tubular cells" (Schlauchzellen), which gives no indication of their contents. The characteristic and universal constituent of their contents is a fatty oil, with which may be associated protoplasm, a pigment or its chromogen, various salts, and tannin. Usually tannin is altogether wanting, and, if present, is only in minute traces. Anthocyan may occur, but is not generally present. The cells which contain anthocyan are generally independent idioblasts, similar to those found in other forms, and quite distinct from the characteristic tubular cells of the Fumariaceæ.

For the demonstration of these cells the author uses potassium biniodide, or an alcoholic or aqueous solution of iodine, by which their contents are coloured yellow-brown or dark-brown, the oil and protoplasm as well as the tannin. If an alcoholic solution is used, the brown colour soon disappears, owing to the great solubility of the oil in alcohol. The author considers the best reagent for tannin to be the neutral salts of iron; potassium bichromate may also be used.

Super-endodermal Network in the Root of the Caprifoliaceæ.‡—M. P. van Tieghem continues to give the result of his researches on the super-endodermal network, as found in the root of various plants. In the present paper this structure is described as it occurs in the various genera of Caprifoliaceæ. In *Viburnum Tinus* and *V. Opulus*, for example, all the super-endodermal cells of the young root are strongly thickened and lignified on their radial and transverse faces. These thickenings are coloured bright red by fuchsin. Here and there a cell of the antepenultimate layer also bears thickening bands. Several

* Ber. Deutsch. Bot. Gesell., v. (1887) pp. 233–8.
† See this Journal, 1887, p. 427.
‡ Bull. Soc. Bot France, xxxiv. (1887) pp. 251–3. Cf. this Journal, 1887, p. 986.

modifications occurring in other members of the same genus are also described. In *Lonicera tatarica* the network is complete, but in *L. xylosteum* and *L. nigra* it is interrupted here and there, especially opposite the woody bundles. In *Symphoricarpus* the network is remarkable on account of the doubling back of the bands on the external face of the cells.

In conclusion, the author states that of the nine genera of Caprifoliaceæ he has examined, six are provided with a super-endodermal network, and three are destitute of that structure. The structure in Caprifoliaceæ agrees with that found in Coniferæ and Rosaceæ, but it differs from the Cruciferæ in that, in the latter case, the meshes are reticulated.

Arrangement of the Fibro-vascular Bundles in Pinguicula.*—MM. P. A. Dangeard and Barbé describe the structure of the fibro-vascular bundles found in *Pinguicula vulgaris*. According to MM. van Tieghem and Douliot,† the conducting bundles may be arranged in three different ways. They may be grouped in a circle, or in several concentric circles, round the axis forming a central cylinder surrounded by endoderm and cortex; or they may be grouped in several circles, round several different axes, forming as many distinct central cylinders; or lastly, they may be isolated, and not united into a central cylinder. In the stem of *Pinguicula* the authors state that the second of these arrangements is found, and that this has only been observed in two other genera of Phanerogams, namely, in *Auricula* and *Gunnera*.

Distribution of Fibro-vascular Bundles in the Petiole.‡—M. L. Petit states that, if a transverse section be made at the caulinary end of the petiole of *Juglans regia*, the fibro-vascular bundles will be found arranged in three circles. These fuse together, and form a single triangular bundle. The arrangement in the other Juglandeæ is somewhat similar, with the exception of the distribution of the accessory bundles situated above this bundle. In *Liquidambar imberbe* the fibro-vascular system is arranged in three arcs of a circle, which form three bundles. These subsequently fuse together, forming a single bundle. In *Bauhinia racemosa* the lateral bundles have their xylem internally, their phloem externally; in the median bundles the phloem faces the median plane, and the xylem is opposite to that of the external bundles.

Vascular Bundles in the Rhizome of Monocotyledons.§—Herr W. Laux describes what he terms the "perixylematic" concentric bundles in the rhizome of *Acorus*, the Juncaceæ, and Cyperaceæ, as contrasted with the "periphloematic" concentric bundles of Ferns, the phloem being, in the former, completely surrounded by a layer of xylem. There is no other difference between these concentric bundles of the rhizome and the collateral bundles of the aerial stem and leaves, except in the relative position of the xylem and phloem. Transitions are exhibited from one form to the other in the gradual collection of the xylem round the phloem; and perixylematic bundles are to be found in the nodes of

* Bull. Soc. Bot. France, xxxiv. (1887) pp. 307–9.

† See this Journal, 1887, p. 260.

‡ Bull. Soc. Bot. France, xxxiv. (1887) pp. 301–3.

§ Laux, W., 'Ein Beitr. z. Kenntn. d. Leitbündel im Rhizom monocotyler Pflanzen,' 49 pp. and 2 pls., Berlin, 1887. See Bot. Ztg., xlv. (1887) p. 611.

the aerial stem of certain species of *Juncus*. Transitional forms between the perixylematic and the collateral structure occur on the same transverse section. The structure of the rhizome of different species of Cyperaceæ shows an almost endless variety in the construction of the bundles.

Comparative Anatomy of Geraniaceæ.*—From an examination of 14 species of *Geranium*, 3 of *Erodium*, and 3 of *Pelargonium*, Herr W. Jännicke gives characters by which these three genera can be distinguished from one another, derived from the structure and distribution of the vascular bundles in the leaf-stalk and flower-stalk.

Anomalous Thickening in the Roots of Cycas.†—Mr. W. H. Gregg finds in *Cycas Seemanni*, in addition to the abnormal thickenings of the stem well-known in several genera of Cycadeæ, similar thickenings in the root. These abnormal thickenings of the root always proceed from the pericambium, which consists of several layers of cells. The primary thickening presents the peculiarity that the normal relative positions of the xylem and phloem are reversed, the former lying outside, the latter inside. This is followed by an outer secondary abnormal thickening, in which the xylem and phloem occupy their normal relative position.

Formation of Annual Rings in Wood.‡—Herr G. Krabbe dissents from the explanation of the formation of annual rings offered by Wieler, that it is due to a difference in the supply of nutriment at different periods of the year, less in the latter part of the summer than in the spring. He asserts that this difference rests on no experimental basis—Hartig maintaining exactly the opposite—and considers that the cause of the formation of these rings is still an unsolved problem in vegetable physiology.

Mechanical system of Pendent Organs.§—Herr A. Y. Grevillius has investigated the peculiarities of structure of the mechanical tissues in a number of plants, both shrubby and herbaceous, whether pendent varieties or organs normally pendent. He finds their general characteristic to be that the organs in question are narrower and more slender, and have their mechanical system less strongly developed, and with a stronger tendency to assume a central position.

Comparative Anatomy of Roots.‖—Dr. O. Lohrer has examined the histological structure of the roots of representatives of a large number of natural orders, to determine to what extent characters of this kind are common to all the members of groups or families. He finds it to differ in different cases.

Members of fifteen families of Papilionaceæ examined all agreed in these points:—The bast is chiefly prosenchymatous; the bast-fibres lie scattered or in small groups in and above the soft bast; their cell-cavity is extremely small; the very thick refringent cell-wall is clearly dif-

* Abh. Senckenberg. Naturf. Gesell., xiv. (1886) 24 pp. and 1 pl. See Bot. Centralbl., xxxi. (1887) p. 36.

† Ann. of Bot., i. (1887) pp. 63–70 (1 pl.).

‡ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 222–32.

§ Naturv. Studentsällsk. Upsala, March 10, 1887. See Bot. Centralbl., xxxi. (1887) p. 398.

‖ Wigand's Bot. Hefte, ii. (1887) pp. 1–43 (2 pls.).

ferentiated from the primary membrane; their diameter in transverse section is small.

The Caryophyllaceæ are also characterized, with some exceptions, by distinguishing peculiarities in the structure of the root. The extra-cambial tissue is usually strongly collenchymatous. The walls of the short cells of the prosenchyma are thin or collenchymatous, but never lignified in the entire xylem.

The root of the Chenopodiaceæ is distinguished by its regular concentric arrangement. The Cruciferæ include several different types; and the author appends a *clavis* by which it can be determined to which of the species examined any given crucifer-root belongs. In other orders the characters of the root are by no means so uniform; while in other cases those of particular species are very sharply marked off from all others nearly allied to them. This is the case with *Urtica dioica* and *Rheum rhaponticum*.

With regard to the rhizome, the author finds that it generally differs from the root in essential anatomical characters, as in the position and form of the vascular bundles; and from the stem in the strongly developed cortical parenchyma. A true endoderm in the root was observed in only one instance, that of *Helleborus niger*.

(4) Structure of Organs.

Respiratory Organs.—Herr L. Jost * proposes the term "pneumathode" for those parts of plants which are especially adapted by their structure for respiration, such as aerial roots. These are of specially frequent occurrence in many species of palm belonging to the genera *Livistona*, *Phœnix*, and others. In *L. australis* they may rise erect to a considerable height (the result of negative geotropism), and are furnished with an evident root-cap. The "pneumathodes" here are certain white spaces where the ordinary brown epidermis is replaced by cells of peculiar form, containing air, and very loosely connected with one another. In other palms the pneumathodes do not occur on roots rising erect in the air, but on those with a normal horizontal position, or they are found on ordinary lateral roots. It was shown by experiment that the tendency of an abundant supply of water is to promote the production of aerial roots; while, when the supply of water is limited, the pneumathodes are formed beneath the soil. The influence of water on the direction of the growth of roots is, however, indirect rather than direct; hydrotropism could not cause the roots to rise erect out of the water; the author considers that it may in great measure be attributed to the properly-named "aërotropism" by Molisch.†

The structure of the vascular bundle in the pneumathode differs in no respect from that in the other parts of the root; in the cortical parenchyma the elongated intercellular spaces have almost entirely disappeared, as also the epidermis and the hypodermal sclerenchymatous ring, the latter being replaced by a sclerenchymatous layer beneath the peripheral spongy layer of thin-walled cells.

Further illustrations of pneumathodes are afforded by *Pandanus furcatus* and *pygmæus*, *Saccharum officinarum*, *Cyperus textilis*, *Luffa amara*, *Taxodium distichum*, and other perennial plants.

* Bot. Ztg., xlv. (1887) pp. 601–6, 617–28, 633–42 (1 pl.).
† Cf. this Journal, 1885, p. 96.

In commenting on this paper Herr K. Goebel * points out that he has already ascribed † to the aerial roots of *Sonneratia* and *Avicennia* the property of serving as organs of respiration, their production being incited by the peculiar habitat.

Organs of Secretion.‡—Herr A. Tschirch has continued his investigations on the secretions and secreting structures of plants. (1) The epidermal glands of Labiatæ and Compositæ, which contain ethereal oil, are formed on two different types. In Labiates, wherever the glands occur, they consist of a ring of secreting cells which lie beside one another in fours or a multiple of four. The head-cell is divided by radial partitions at right angles to the surface of the organ. In Compositæ, on the other hand, the cells are arranged in layers one above the other, often only the two upper layers secrete; all the secreting cells are divided by a median radial partition, usually at right angles to the longitudinal axis of the organ. In the head-cell tangential walls parallel to the surface are first formed, then a radial partition in each of these divisions. From the surface the glands of Labiatæ exhibit a central cell with a surrounding ring usually of eight, while those of Compositæ form an elongated oval divided through the centre.

(2) The origin of copaiva balsam is unique. The balsam is exclusively formed in the wood, and there in the older portions. It arises by retrogressive metamorphosis first of the walls of the vessels, but implicating also the adjacent cells. Even in one-year twigs the metamorphosis of some vessels was observed. Except in the case of the very different "resin-gallen" of Conifers, this is the first certain illustration of the possible modification of cellulose into resin or resin-like substances.

(3) In a second paper Herr Tschirch notes that the seat of the cinchona-alkaloids is almost exclusively the cortical parenchyma, and the contents of the cells. This cortical parenchyma is greatly increased in the secondary cortex, while all the other elements of the bark disappear. The increase in the alkaloid content depends chiefly on an increased development of the thin-walled alkaloid-bearing tissue elements, not on an increase of the absolute content of the individual cells. The alkaloids pass only secondarily in the dry bark into the cell-walls.

Anatomy of Water-plants.§—Dr. H. Schenck sums up the anatomical characters of plants which grow entirely submerged in water.

The leaf is almost always divided into capillary teeth, or is a narrow grass-like ribbon; exceptions are afforded by some species of *Potamogeton*. The parenchyma does not assume the spongy form with large intercellular lacunæ, the cells being prismatic in form and fitting closely together without intercellular spaces, or else inclosing very large lacunæ in the interior; stomata are very rare, and the greater part of the chlorophyll is contained in the epidermis. The vascular bundles are of very simple structure, and are inclosed in a parenchymatous sheath, which does not differ essentially in structure from the surrounding

* Bot. Ztg., xlv. (1887) pp. 717–8. † See this Journal, 1887, p. 111.

‡ Versamml. Deutsch. Naturf. u. Aerzte, Wiesbaden, Sept. 21, 1887. See Biol. Centralbl., vii. (1887) p. 133.

§ Uhlworm und Haenlein's Biblioth. Bot., i. (1886) pp. 1–67 (10 pls.). Cf. this Journal, 1886, p. 272.

parenchyma. The special development of the leaf is described in a number of individual cases. The large air-cavities may be either schizogenous or lysigenous.

The mechanical system of the whole plant is reduced to a very feeble development. Organs for secretion and excretion are, as a rule, entirely wanting, though calcium oxalate is sometimes excreted abundantly. The root-system of submerged plants seldom attains any great development. The central vascular cylinder is probably formed from the union of a number of bundles.

Lateralness in Coniferæ.*—The term "lateralness" of an organ is defined by Herr E. Henning as expressing the distribution of the phenomena of organization on the transverse section, or especially around the axis of growth. Strictly speaking, all the leaves of conifers are dorsiventral, since the vascular bundles are collateral. He describes the lateralness of a leaf as radiar when the tissues are uniformly developed around the vascular bundle, and if the leaf has, in addition, a circular or polygonal transverse section; bilateral when they are flat while the structure of the tissue is the same. A table is given of the variations, within the order of Coniferæ, of the combinations of these and some other differences of structure connected with the lateralness of the leaves and branches.

Dichotypy.†—Herr W. O. Focke adduces the following instances of dichotypy, i. e. of the occurrence of two different forms of the same organ on the same stock:—A number of specimens of a hybrid between *Anagallis phœnica* and *A. cærulea*, in which most of the flowers were scarlet, a single one having half one of the corolla-lobes dark blue; a specimen of *Mirabilis Jalapa*, in which most of the shoots had white flowers sprinkled with red, a few pure red flowers; and a hybrid between *Trollius europæus* and *T. asiaticus*, in which most of the flowers were yellow, those on a single branch red.

Flowers and Fruit of Sparganium and Typha.‡—This treatise by Dr. S. Dietz is now published in detail, with illustrations. The two genera should, he considers, be placed under distinct families, or at least sub-families, *Sparganium* having a nearer affinity to the Pandanaceæ, *Typha* to the Aroideæ. The fruit of *Typha* is a caryopsis, that of *Sparganium* a drupe.

Fruits and Seeds of Rhamnus.§—Prof. H. Marshall Ward (assisted by Mr. J. Dunlop) has conducted a series of experiments for the purpose of explaining the phenomena connected with the colouring matter of species of *Rhamnus*, especially *R. infectorius*. A beautiful golden yellow solution can be obtained by macerating the fruit in water; but, although the seat of the pigment is evidently the pericarp, the whole berry, including the seed, must be crushed in order to obtain it. The explanation of this phenomenon offered by Prof. Ward is that the xanthorhamnin present in the pericarp is a glucoside, and that it breaks up, under the influence of a ferment present in the seed, into the

* Naturv. Studentsällsk. Upsala,' Feb. 24, 1887. See Bot. Centralbl., xxxi. (1887) p. 393.

† Abhandl. Naturwiss. Ver. Bremen, ix. (1887). See Bot. Centralbl., xxxii. (1887) p. 43.

‡ Uhlworm und Haenlein's Biblioth. Bot., v. (1887) pp. 1–59 (3 pls.). Cf. this Journal, 1887, p. 114.

§ Ann. of Bot., i. (1887) pp. 1–26 (2 pls.).

colouring substance rhamnin, and glucose. Further experiment showed that the seat of this ferment in the seed is nearly or quite exclusively the raphe. If to a fresh solution of the boiled pericarp a very small portion of the raphe is added, a copious precipitate is almost immediately obtained of semi-crystalline yellow masses of rhamnetin. The cells of the raphe are found to contain a brilliant oily-looking colourless substance. No trace of this ferment was found in four other species of *Rhamnus* examined, viz. *R. tinctorius*, *carolinianus*, *Wicklius*, and *catharticus*. As to the nature of the ferment, nothing definite was determined.

Prof. Ward suggests that the purpose of this arrangement is the production of glucose as soon as the seed begins to germinate, for the nutrition of the young seedling.

Masked Fruits.*—Herr A. N. Lundström describes the heterocarpic condition exhibited by *Calendula* and *Dimorphotheca*. In the former (1) wind-transportable, (2) hook-bearing, (3) larva-like fruits occur. He gives reasons for regarding the resemblance between the last-mentioned fruits and the caterpillars of certain butterflies as indeed a case of mimicry.

Development of the Fruit of Umbelliferæ.†—Messrs. J. M. Coulter and J. N. Rose describe the development of the fruit in Umbelliferæ, *Chærophyllum procumbens* being selected as a type.

In very young buds groups of three or four parenchyma-cells of the pericarp, next the inner epidermis, begin to be set apart for the formation of oil-ducts. The first indication of this is that they become secreting cells, and are discoloured by the characteristic oily contents, and also become larger than the surrounding parenchyma-cells. Upon approaching the period of flowering, the parenchyma-cells surrounding each fibrovascular bundle subdivide, and when the flower opens, quite a distinct group of small parenchyma-cells is discovered beneath each rib; these subsequently develope into strengthening cells. The extension of undifferentiated parenchyma is effected by radial cell-division, the amount of tangential division being comparatively small.

Axis of the Inflorescence.‡—Herr O. Klein describes in detail the comparative anatomy of the axis of the inflorescence. The epidermis is not strongly thickened, except in those cases where the inflorescence persists through the winter, as in that of the male catkins of the birch and hazel; here it is strongly suberized. The cortex consists either of chlorophyllous or of non-chlorophyllous cells. The cortical parenchyma increases with the ascending order of the branches, at the expense of the mechanical tissue, especially where the inflorescence is destitute of leaves, as in the Juncaceæ. The vascular bundles retain nearly the same diameter throughout, but their constitution alters; the hadrome continually diminishing towards the apex, while the leptome increases to a corresponding extent. The number of bundles decreases with the constant decrease in the diameter of the axis. The axis of the inflorescence of Umbelliferæ is treated in detail, especially in regard of its power of bending.

* Nov. Act. Reg. Soc. Scient. Upsala, xiii. (1887) pp. 72–7.

† Bot. Gazette, xii. (1887) pp. 237–43 (1 pl.).

‡ Jahrb. K. Bot. Gart. Berlin, iv. (1886) pp. 333–63. See Bot. Centralbl., xxxii. (1887) p. 107. Cf. this Journal, 1887, p. 989.

Development and Structure of Orobanche in a young stage, and of its suckers.*—M. M. Hovelacque describes the development and structure of *Orobanche*, taking as his type *O. cruenta*.

In a very early stage the *Orobanche* appears on the host as a circular or curved spot. The parasite has penetrated the fibrovascular bundles of its host, and consists of a single unramified sucker which now begins to enlarge rapidly. When more developed, the young *Orobanche* appears as a hemispherical swelling; it is, however, impossible to distinguish growing point, axis, or appendages. At a later stage the vegetative point is found to consist of dermatogen, which layer covers a meristematic mass undifferentiated into periblem and plerome. At the base of the growing point the first leaves appear in their order. Certain procambial threads reach from the fibrovascular bundle of the sucker to the more developed leaves. The points of growth of the roots may be seen in the middle of a mass of cortical tissue, the elements of which are large.

Young plants of *O. minor* differ from *O. cruenta* in that they are provided with more numerous roots. In *O. Hederæ*, on the contrary, the roots are less numerous, and develope more slowly, but the adventitious buds are more numerous.

M. Hovelacque classifies the suckers of *Orobanche* under four types, viz.:—(1) Small unicellular suckers. When the root of an *Orobanche* touches the nourishing root of a host by a very small point, this contact is often limited to a single cell of the superficial layer. The morphological value of these suckers is that of root-hairs. (2) Small multicellular suckers. When the contact with the host affects more than one cell, these cells elongate and penetrate the host in a single mass. (3) Large unramified suckers. When the surface of contact of the parasitic root with the nourishing root is very large, many of the superficial cells take part in the formation of a sucker. In this case the sucker partakes of the character of a very imperfect root. (4) Large ramified suckers. Ramified suckers differ from the preceding only in the fact that, when penetrating the root of the host, they branch. In this last case the suckers of *Orobanche* are homologous to a bundle of imperfect roots.

Origin of the Suckers in Phanerogamous Parasites.†—M. Granel states that in *Melampyrum pratense* the suckers arise in the cortex. The cells of the piliferous layer, after elongation, divide into a filament of cells; one, two, or three cells from the middle of each filament elongate rapidly towards the exterior, and imbed themselves in the host.

Among plants with temporary suckers, some develope their organs of absorption on their roots; these are, for example: *Osyris alba*, *Thesium*, *Melampyrum*, *Orobanche minor*. In others the suckers arise in the stem; for example: the *Cuscuteæ*, *Cassytha*, &c. *Osyris alba* possesses a large number of normal roots, and also has suckers. It presents then a coexistence of free and parasitic life. In conclusion the author states that in *Osyris alba*, *Orobanche minor*, and *Thesium divaricatum*, the origin of the suckers is to a great extent identical; they arise in the cortical parenchyma, and are joined slowly by some cells formed by the pericycle.

Arrangement of Secondary Roots and Buds on Roots.‡—M. P. van Tieghem discusses the laws which govern the arrangement of the lateral

* Comptes Rendus, cv. (1887) pp. 470–1, 530–3.
† Bull. Soc. Bot. France, xxxiv. (1887) pp. 313–20.
‡ Ann. Sci. Nat.—Bot., v. (1887) pp. 130–51.

roots and buds on the root and lower part of the hypocotyl of Phanerogams in those cases where the structure of these organs is binary. In all these cases, which are very common, the root, whether terminal or lateral, primary, secondary, or of any other order, forms its subsidiary roots in the pericycle in front of the intervals which separate its two xylem-bundles from its two liber-bundles, and places them in consequence in four longitudinal rows. The author terms those rootlets "isostique" when the mother-root has more than two, "diplostique" when it has only two xylem-bundles. Whenever a root, whether primary, terminal, or lateral, is binary, its branching is governed by the second of these laws. The same law governs the arrangement of the normal buds which frequently make their appearance on the hypocotyl.

The local production of double roots and double buds is not uncommon, especially in Umbelliferæ. The normal hypocotyledonary buds above alluded to almost always spring from the pericycle of the root or of the stem; the only known exception is in the case of the Linariaceæ, where they are of exogenous origin.

Epidermal Glands.*—M. P. Vuillemin has examined the structure of the epidermal glands in the natural orders Plumbaginaceæ, Frankeniaceæ, and Tamariscineæ. In those of the two latter orders he finds a very strong similarity to one another. Those of the Plumbaginaceæ, while resembling the glands of the other two orders in their structure, origin, and functions, yet present some well-marked morphological differences. They are, in all three orders, hairs transformed into organs of excretion, and intended to complement the action of the stomata. They detain the waste products arrested by the thick walls which bound the intercellular spaces, but which are able to pass through the walls of these secreting cells, which are always punctated, the gland opening outwards through a very narrow orifice, and being always lined at its base with a layer of protoplasm.

In the Plumbaginaceæ each gland always consists of eight secreting cells. The substance secreted may be entirely volatilizable, or may be mucilaginous, or may contain a large quantity of salts of lime in solution, which is deposited, on evaporation, over the whole surface of the leaf. In the Frankeniaceæ and Tamariscineæ each gland consists of only two secreting and two subsidiary glands. The secretion is, in the Frankeniaceæ, generally calcareous, solidifying on evaporation; while in the Tamariscineæ it is resinous, not yielding a calcareous concretion on evaporation.

Prickle-pores of Victoria regia.†—Mr. J. H. Blake, having examined the large prickles on the leaf-veins and petioles of *Victoria regia*, finds that only the larger ones are penetrated by a fibrovascular bundle, and that the opening or ostiole described as existing at the apex of the spine is not invariably present, and is probably the result of injury.

Morphological Peculiarity of Cordyline australis.‡—Prof. F. O. Bower records a peculiarity in this plant growing in Ceylon, that, when the stem assumes an oblique or horizontal position, lateral shoots are put out from the lower side of the main axis, which direct themselves vertically downwards. They are of exogenous origin, with exceedingly

* Ann. Sci. Nat.—Bot., v. (1887) pp. 152–77 (1 pl.).
† Ann. of Bot., i. (1887) pp. 74–5.
‡ Proc. Phil. Soc. Glasgow, xviii. (1887) pp. 317–9 (1 pl.).

slow growth, and produce roots of endogenous origin. In their function of root-bearing organs they bear a resemblance to the rhizophores of *Selaginella*.

Nyctagineæ.*—From the special examination of three species, *Mirabilis Jalapa*, *M. longiflora*, and *Oxybaphus nyctagineus*, Herr A. Heimerl gives the following as the most characteristic peculiarities of the order:—

The ovule presents an intermediate form between the campylotropous and anatropous. The conducting apparatus for the pollen-tubes is remarkably well developed. The three antipodal cells are already invested with cell-walls before impregnation, and continue for a time after this. The endosperm is inconsiderable in quantity, and transitory; the perisperm, on the other hand, very fully developed. The wall of the ripe pericarp is of complicated structure, with a central sclerenchymatous layer, and an outer layer containing tannin. Cells containing raphides are very abundant in the short prolongation of the floral axis on which the ovary is seated, and in the lower part of the pericarp; in smaller quantity also in the wall of the ovary; they are altogether wanting in the ovules. The ripe fruit is inclosed in a very thin brown skin, formed by the fusion of two layers, the outer of which is developed from the outer epidermis of the ovary, the inner and stronger one from the testa of the seed.

Root-tubers and Bacteria.†—Herr P. Sorauer sums up succinctly the results of the observations of Tschirch, Woronin, Kny, Brunchorst, Hellriegel, Eriksson, Frank, Benecke, and Möller, on the true nature of the root-tubers in Leguminosæ, as well as in Elæagnaceæ and in *Alnus*.

β. Physiology.‡

(1) Reproduction and Germination.

Insect relations of Asclepiadeæ.§—Mr. C. Robertson describes the insect relations of certain Asclepiads. He states that while in ordinary flowers an insect may be a useful visitor if it can reach the nectar, in *Asclepias* many other conditions influence the insect relations. Of visitors whose tongues are suited to the nectaries, many are useless, because they do not light upon the flowers (Sphyngidæ, Ægeriadæ, and *Trochilus*); others because their legs are not long enough to extract pollinia (*Megachile*). Others, again, rest their feet so lightly as seldom to effect pollination; e. g. Diptera and small butterflies; while others are not strong enough to free their claws from the slits and break the retinacula. In all seventeen species were found to be killed on this account.

The author describes in detail several species of the genus *Asclepias*, and also two species of *Acerates*.

Fertilization of Flowers.‖—Dr. J. MacLeod has added a sort of appendix to the classic work of Hermann Müller on the fertilization of flowers. He has extended and corroborated the work of the great

* Denkschr. K. Akad. Wiss. Wien, liii. (1887) 3 pls.

† Bot. Centralbl., xxxi. (1887) pp. 308–14, 343–5.

‡ This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth (including Movements of Fluids); (3) Irritability; and (4) Chemical Changes (including Respiration and Fermentation).

§ Bot. Gazette, xii. (1887) pp. 207–16, 244–50.

‖ Arch. de Biol., vii. (1887) pp. 131–66 (1 pl.).

master observer in this department. The flowers studied were *Silene Armeria*, *Stellaria graminea*, *S. uliginosa*, *Sagina procumbens* var. *apetala*, *Hibiscus syriacus*, *Viola*, *Potentilla Fragaria*, *Ribes nigrum*, *Lysimachia vulgaris*, *Ajuga reptans*, and *Teucrium Scorodonium*.

He notes, in regard to varieties of *Lysimachia vulgaris*, that in some direct fertilization is certain, in others all but impossible. He calls attention to the different forms of sexual arrangements observed in *Stellaria graminea*. In *Teucrium* a peculiarity results in cross-fertilization, not only between different flowers, but between different inflorescences.

The Caryophyllaceæ are disposed in two classes:—(1) Where self-fertilization is entirely or almost entirely impossible; (2) where cross-fertilization is less perfectly insured, and where self-fertilization may, in case of need, occur.

Flowering of Euryale ferox.*—It has been a matter of controversy whether this plant, belonging to the Nymphæaceæ, opens its flowers above or below the surface of the water. From observations made in the botanic gardens at Rome, Prof. G. Arcangeli concludes that the flower is perfected under water, and is cleistogamous, self-fertilization taking place in a kind of chamber formed by the perianth, the stigmatic disc, which is curved into the form of a cup, and the stamens.

(2) Nutrition and Growth (including Movements of Fluids).

Growth and Origin of Multicellular Plants.†—Mr. G. Massee describes the structure and mode of formation of the gelatinous membrane exterior to the true cellulose-wall, and extending continuously over the whole plant, which is not uncommon in Algæ, and universal in the Florideæ. It can be clearly shown that the formation of the cellulose-wall never precedes that of the mucilaginous sheath, and its function is rather a supporting than a protecting one. The composition of the mucilaginous sheath closely resembles, or is identical with, that of protoplasm. The sheath is usually homogeneous, even after the appearance of the cell-wall; but in *Pandorina* the innermost portion consists of parallel rods placed end to end on the cell-wall; while in *Cladophora crispata* the rods run parallel to the surface of the wall. The portion consisting of rods stains readily with methyl-violet and other anilin dyes, while the homogeneous portion does not stain.

In some cases, as in *Polysiphonia*, the surface of the sheath is more or less papillose, and not unfrequently a papilla may be seen to extend itself into an exceedingly fine cilium, varying in length from 5 to 100 μ, and less than 1 μ thick. These cilia are plastic and flexible, but have no spontaneous vibratile motion. They appear not to be unlike those described by the author as occurring on the surface of some of the large stipitate glands on the underground leaves of *Lathræa squamaria*.‡

The outermost layers of this mucilaginous sheath often become strongly cuticularized, while the inner portions do not change in their chemical reactions. Internally, as in the stipes of many Algæ, it is secreted in such quantities as to force the cells apart, and destroy the connecting strands of protoplasm; and within this mucilaginous matrix strings of new cells appear as outgrowths from older cells.

* Atti Soc. Tosc. Sci. Nat., viii. (1887) pp. 281–300.

† Journ. of Bot., xxv. (1887) pp. 257–67. ‡ See this Journal, 1887, p. 111.

The change from a unicellular to a multicellular condition appears to be due to the influence of this external sheath. In Algæ the cellulose cell-wall is formed in the middle of this sheath. In unicellular Algæ the tendency to form colonies is due to the copious secretion of mucilage, which is external to, and quite distinct from the sheath; and the primary function of which appears to be to prevent desiccation. This, again, has its analogue in the higher plants in the copious secretion of mucilage from the stipules of *Anomoclada* among Hepaticæ, and from the mucilage-cells of *Blechnum* and *Osmunda*. Plants remain unicellular so long as the tendency of the protoplasm to resolve itself into a sphere, after cell-division, predominates over external forces; and the same occurs where cells are free from the pressure of the surrounding tissues, as in pollen-grains.

The cap-like structure which covers the growing point in *Oscillaria* is simply the relatively thick undifferentiated portion of the sheath, which contracts as it becomes cuticularized.

The ring-like structure at the distal end of the cells of *Œdogonium* is described in detail, and is regarded by the author as only a special form of apical growth, combined with an unusual rigidity of the investing sheath.

Influence of Light on the Form and Structure of Leaves.*—A series of experiments on the influence of various degrees of illumination on the size and internal structure of leaves has led M. L. Dufour to the following conclusions:—

The development of the plant increases in proportion to the degree of illumination. It increases in size, it branches more copiously; its stem and branches exceed in diameter the corresponding parts of the same plant exposed to a less degree of illumination; its leaves attain the largest dimensions both in surface and in thickness; and the flowering is earlier and more abundant.

The same law applies also to the internal structure of the leaf. The stomata are more abundant. The elements of the epidermis are more fully developed in the sun; the cells are larger, with thicker lateral and outer walls; the cuticle, in particular, is more strongly developed. The walls of the epidermal cells are more sinuous in the sun than in the shade. The palisade-parenchyma also displays a stronger development; its cells are longer in the transverse direction than when the plant grows in the shade; they contain more chlorophyll and more starch. The same also is true of the conducting tissue; the vessels are more numerous and larger. The strengthening tissue presents the same characters as those displayed in the sclerenchymatous and collenchymatous elements. The secreting canals are larger, and contain larger quantities of eliminated substances, and the same is true of the deposition of calcium oxalate.

As a general law, M. Dufour comes to the conclusion that the statement of some previous observers that there is an optimum degree of illumination for the plant considerably below that derived from the direct rays of the sun, is incorrect; and that, other things being equal, the plant, and every part of the plant, is more fully developed in proportion as it is exposed to a more intense illumination.

* Ann. Sci. Nat.—Bot., v. (1887) pp. 311–413 (6 pls.). Cf. this Journal, 1887, p. 824.

(4) Chemical Changes (including Respiration and Fermentation).

Exhalation of Oxygen by fleshy-leaved Plants in absence of Carbonic Anhydride.*—Herr A. Mayer, by former researches, has shown that under certain conditions oxygen is exhaled by the leaves of some plants in absence of carbonic anhydride. This is more especially the case with the Crassulaceæ; and it was found that leaves of *Bryophyllum calycinum*, which contain malates, after a period of darkness (during night) have an acid reaction, but during the daytime this reaction becomes much less. The author's experiments, made since 1883, show that "acid leaves," during insolation in an atmosphere free from carbonic anhydride, yield more oxygen the richer they are in free acid. The acid present is malic acid; and this acid and the calcium salt diminish during insolation, just as if the whole consisted of free acid, the products resulting from the change being starch, sugar, &c., and the amount of oxygen which should be separated by the produced carbohydrates agrees well with the quantity of oxygen found to be set free by insolation.

Respiration of the Potato.†—Herr J. Boehm gives the results of a large number of experiments on the exhalation of carbonic acid by potatoes, whether ordinary or sweet, injured or uninjured. As in the case of seedlings of *Phaseolus multiflorus*, the intensity of the respiration is, in most cases, independent of the partial pressure of oxygen, though there are conditions under which this is not the case. Herr Boehm finds that when cut into pieces, potatoes respire much more energetically than when uninjured. The internal respiration is independent of external injury, and is much more intense with sweet than with ordinary potatoes; but in both cases the internal respiration is greatly increased, with cut potatoes, when they are previously placed for a day in moist air at a temperature favourable for normal respiration.

Action of Formose on Cells destitute of Starch.—By experiments on *Fraxinus Ornus*, *Rubia tinctorum*, *Syringa vulgaris*, and *Cacalia suaveolens*, Dr. C. Wehmer‡ has determined that formose ($C_6H_{12}O_6$, obtained by the condensation of formic aldehyde) belongs to the class of carbohydrates which living leaves have not the power of converting into starch; agreeing in this respect with milk-sugar, raffinose, inosite, dextrin, erythrite, trioxymethylen, and some organic acids; and differing from dextrose, levulose, galactose, maltose, cane-sugar, mannite, dulcite, and glycerin.

Commenting on this paper, Herr O. Loew§ disputes the accuracy of some of Dr. Wehmer's results, and especially dissents from a conclusion drawn by that gentleman from the fact that he was unable to obtain starch from formose. This induces Wehmer to oppose the recent view that formic aldehyde is the first product of assimilation in plants, but, as Loew thinks, on insufficient grounds.

γ. General.

Biology of Orobanche.‖—Herr L. Koch describes in detail the life-history of several species of *Orobanche*. The seeds, which are produced

* Landw. Versuchs-Stat., xxxiv. pp. 127–43. See Journ. Chem. Soc., 1887, Abstr., p. 988.

† Bot. Ztg., xlv. (1887) pp. 671–5, 681–92.

‡ Bot. Ztg., xlv. (1887) pp. 713–7.

§ Ibid., pp. 813–4.

‖ Koch, L., 'Die Entwicklungsgeschichte der Orobancheen,' 389 pp. and 17 pls., Heidelberg, 1887. See Bot. Centralbl., xxxi. (1887) p. 361.

in enormous numbers, 100,000 to 150,000 on an individual, can germinate only when in contact with the root of the host; they may retain their power of germination for two years. The embryo developes into a filiform structure; and the penetration is effected, as with parasitic fungi, by a secretion from the parasite which dissolves the tissues of the host. The young plant penetrates to the vascular bundle of the host, but does not appear to inflict any serious injury upon it. In the endogenous formation of the growing point *Orobanche* shows a resemblance to *Rafflesia*. The structure described by some writers as an "intermediate organ" between host and parasite, results simply from the common growth of the parasite and of the root of the host. From the true haustorium, the portion of the parasite which first penetrates the tissue of the host, secondary haustoria spring, which serve for its non-sexual reproduction.

With regard to the plants from which the various species of *Orobanche* derive their nourishment, this is not altogether indifferent; each species of parasite has only certain hosts on which it will grow, though these may be numerous and not necessarily nearly related to one another; thus *O. ramosa* is parasitic on the hemp and on tobacco. *O. minor* was found to grow on forty-four different species, *O. ramosa* on twenty-nine, *O. speciosa* on thirteen, and *O. Hederæ* on three species of host-plant.

Biology of the Mistletoe.*—Dr. M. Kronfeld describes at length the mode of life and germination of the mistletoe. He states that the popular idea that the seeds can germinate only after passing through the intestinal canal of a bird, is correct only with considerable limitation. No doubt seeds are occasionally passed with the excreta, and are then in a favourable condition to germinate. But the majority of the seeds are rejected by birds when feeding on the white pulp of the fruit. The seeds can easily be made to germinate in the ordinary way, but require a long period of rest after ripening. The mistletoe is also propagated non-sexually by buds. Polyembryony occurs normally, a very large proportion of the seeds containing two or three embryos.

The development of the plant varies greatly, according to the tree on which it is parasitic; and this has been the source of the manufacture of a large number of false species. It will grow on almost any tree except certain conifers. It is least luxuriant on other species of Coniferæ; most so on *Robinia Pseudacacia*.

Root-symbiosis in the Ericaceæ.†—Herr B. Frank finds this to be an almost universal phenomenon in the Ericaceæ. The roots afflicted in this way are distinguished by their extraordinary tenuity (0·07–0·05 or even 0·03 mm.), greater length, and sparsity of branching. They usually consist of nothing but a single slender fibrovascular bundle and epidermis, the root-hairs being altogether suppressed. The epidermis is well developed; the cell-cavities are large, and completely filled by an irregularly interwoven mass of fungus-hyphæ. They are also enveloped in a weft of hyphæ, which do not, however, form a closed envelope, but are connected in a variety of ways with the intercellular hyphæ. The

* Biol. Centralbl., vii. (1887) pp. 449–64 (3 figs.).

† SB. Versamml. Deutsch. Naturf. u. Aerzte, Wiesbaden, Sept. 21, 1887. See Bot. Centralbl., xxxii. (1887) p. 57. Cf. this Journal, 1886, p. 113.

mycorhiza was found in all the localities examined, whether moory or heathy; and on the following species:—*Vaccinium uliginosum*, *Oxycoccus*, *Myrtillus*, and *Vitis-Idæa*, *Andromeda polifolia*, *Ledum palustre*, and *Calluna vulgaris*, as well as on cultivated specimens of *Vaccinium macrocarpum*, *Azalea indica*, and *Rhododendron ponticum*, and on *Empetrum nigrum*.

Domatia.*—Dr. A. N. Lundström defines as "domatia" those formations or transformations on plants adapted to the habitation of guests, whether animal or vegetable, which are of service to the host, in contrast to cecidia, where such habitation is injurious to the plant. He describes these domatia in detail on the lime, alder, hazel, and other trees and shrubs, and gives a very long list of species, belonging to a great variety of natural orders, on which they are found.

The principal types of shelter are as follows:—(1) Hair-tufts, e. g. in *Tilia europæa;* (2) recurvatures or foldings in various parts, e. g. in *Quercus robur*, *Ilex*, *Schinus*, *Ceanothus africanus;* (3) grooves without hairs, as in *Coffea arabica*, *Coprosma baueriana;* with marginal hairs, e. g. in *Psychotria daphnoides*, *Rudgea lanceolata*, *Faramea*, *Rhamnus glandulosa*, *Coprosma Billiardieri;* with basal hairs, as in *Anacardium occidentale;* (4) pockets, as in *Elæocarpus oblongus*, *E. dentatus*, *Psychotria*, *Lonicera alpigena;* (5) pouches, e. g. *Eugenia australis*. These different types of domatia are connected by transition forms. The habit of producing domatia in a species may become hereditary without the actual presence of the predisposing cause. Certain orders, e. g. Rubiaceæ (famous also for ant-domatia), show a marked predisposition to acarodomatia. Many groups seem entirely without them, e. g. Monocotyledons and Gymnosperms, and all herbs. They are most abundant and best developed in tropical (and temperate) zones.

In the second chapter the author discusses in detail the various interpretations which may be put upon domatia. (1) They may be pathological, like galls; (2) they may be for catching insects; (3) they may have only an indirect connection with their tenants; (4) they may be of use to the plant as the dwellings of commensals. He adopts the last interpretation. He draws an interesting parallel, however, between galls and domatia, and is inclined to suppose that the domatia were first directly caused by the insects, but have gradually become inherent transmitted characteristics. The author gives a clear table, distinguishing the cecidia or galls due to "antagonistic symbiosis," either plant or animal (phyto- and zoo-cecidia), and domatia due to "mutual symbiosis," either plant or animal (phyto- and zoo-domatia). Those due to plants are again subdivided into myco- and phyco-cecidia or -domatia.

Myrmecophilous Plants.†—Herr A. N. Lundström observes that several species of *Melampyrum* are provided with dot-like nectariferous trichomes on their leaves and bracts. These attract large numbers of ants, which he believes are of service to the plant in the following way. The seeds of these species bear an extraordinary resemblance to the larvæ of ants, even to the excrement-sac; and being mistaken for larvæ by the ants, are carried by them to their nests, where they germinate.

Herr Lundström names also a number of myrmecophilous plants

* Nov. Act. R. Soc. Scient. Upsala, xiii. (1887) pp. 1–72 (4 pls.). See this Journal, 1887, p. 273. † Nov. Act. R. Soc. Scient. Upsala, xiii. (1887) pp. 77–88.

belonging to the Scandinavian flora, and describes the contrivance, not hitherto noticed, in the aspen.

Humboldtia laurifolia as a Myrmecophilous Plant.*—Prof. F. O. Bower's description of this plant, a native of Ceylon, is now published in full. He ascribes the formation of the hollow channels in the stem and branches which the ants inhabit in the first place to rupture from tension; and believes that the ants only then fortuitously take possession of them. He sees no evidence that the presence of the ants is of any advantage to the plant. A somewhat similar structure occurs in *Clerodendron fistulosum* n. sp. and *Myristica myrmecophila* n. sp., and in *Nepenthes bicalcarata* from North Borneo.

Oxidation-process in Plants after death.—Herr J. Reinke † brings forward experimental evidence, furnished by Herr G. Brenstein, that after parts of plants have been completely killed by exposure for a considerable time to an atmosphere saturated with vapour of ether, the processes of oxidation and formation of carbonic acid still go on in them; and that this is dependent on temperature even more in the dead than in the living plant.

Herr W. Johannsen ‡ objects to the validity of these experiments, that they were made to extend over too long a period. These processes cease on the death of the plant or part of the plant, but recommence after a time under the influence of bacteria. True intramolecular respiration will go on in an atmosphere destitute of oxygen, from the presence of a fermentative substance, while "post-mortal" oxidation ceases at once in such an atmosphere.

Retrogression in Oaks.§—Herr F. Krašan has followed up his previous "phyto-phylogenetic" studies by a study on the frequent occurrence of abnormal leaves on oaks. The species studied was *Quercus sessiliflora* Sm. His conclusions are as follows:—(1) The phenomena are in origin pathological; (2) the pathological state induces certain modes of growth dormant in normal states; (3) but those structures which develope symmetrically on affected branches and twigs, and unfold themselves uniformly, can no longer be called pathological. It seems very probable (*a*) that the modes of growth evoked by the pathological state are retrogressive. In previous generations the plant had followed similar paths; and indeed, in geological periods with warmer temperature, when the impulse which now evokes these "abnormal" leaves in summer, was constant. (*b*) *Q. aquatica* Walt., in N. America, is approximately in the state of the present *Q. sessiliflora* in the Miocene age, when it was still *Q. tephrodes* Ung. (*c*) By the study of such abnormal conditions much may be learned of phylogeny and relationship.

Phenomenon analogous to Leaf-fall.‖—Mr. F. W. Oliver points out that in *Rubus australis*, a plant in which the lamina is suppressed, the leaves being reduced to simple mid-ribs of the leaflets, a layer of phellogen is formed in the stem in the later part of the summer, out of the innermost of the cortical layers, all of which are assimilative. By this means the rest of the assimilating cortex is cut off from the other tissues, and

* Proc. Phil. Soc. Glasgow, xviii. (1887) pp. 320-6 (1 pl.). Cf. this Journal, 1887, p. 785.
† Ber. Deutsch. Bot. Gesell., v. (1887) pp. 216–20.
‡ Bot. Ztg., xlv. (1887) pp. 762–3.
§ SB. K. K. Akad. Wiss. Wien, xcv. (1887) pp. 31–42.
‖ Ann. of Bot., i. (1887) pp. 71–2.

is cast off in scales during the second year. Fresh assimilating cortex is formed in the shoots of the current year. A somewhat similar process takes place in *Casuarina*.

"Curl" of Peach-leaves.*—Miss Etta L. Knowles sums up briefly the action of *Exoascus deformans* on peach-leaves in the following manner:—

(1) A marked increase in width and thickness, accompanied by great distortion.

(2) Great multiplication of cells, particularly of the palisade-cells and immediately adjacent parenchyma, by cell-division.

(3) Thickening of the cell-walls and disappearance of the intercellular spaces.

(4) Diminution of cell-contents, which often are almost or wholly wanting.

Plant Analysis as an Applied Science.†—In a useful lecture on this subject, Miss H. C. de S. Abbott gives a *résumé* of the more important chemical tests used in discriminating the various substances found in vegetable tissues, and of the practical value of the results thus obtained.

B. CRYPTOGAMIA.

Arthur's Report on Minnesota.‡—The following is an enumeration of the number of species and varieties in each of the families of Cryptogams mentioned in Arthur's Report of Minnesota for 1886:—Pteridophyta 26. Bryophyta 42. Carpophyta 242. Oophyta 11. Zygophyta 45. Protophyta 28.

The following new species are mentioned:—Among the Carpophyta, *Puccinia haleniæ*, *P. ornata*, *Anthostoma flavo-viride*, *Nectria perforata*, *Ramularia variegata*, *Zygodesmus sublilacinus*, *Ciboria tabacina*, *Peziza* (*Dasys*) *borealis*, and *P.* (*Humaria*) *olivatra*; and among the Protophyta, *Synchytrium Asari*.

Cryptogamia Vascularia.

Germination of Ferns.§—Herr K. Goebel describes the germination of the spores of several little-known ferns. In *Vittaria* the first product is a filament which very soon divides into a plate of cells. Club-shaped bulbils are produced in large numbers on the prothallium, consisting of from six to nine cells, and placed upon peculiar semicylindrical sterigmata. Antheridia may be produced on the bulbils.

The germination of the spores of *Trichomanes* was observed in *T. maximum* and *diffusum*. The prothallium is here filamentous; archegonia being produced at the ends, and antheridia at the middle of the filaments. Bulbils were also observed consisting of a single cell placed on a conical sterigma. *Hymenophyllum* has also a filamentous prothallium which produces gemmæ borne on less distinct sterigmata; and the archegonia and antheridia are also described.

Herr Goebel points out the parallelism between the development of

* Bot. Gazette, xii. (1887) pp. 216–8.

† Journ. Franklin Inst., cxxiv. (1887) pp. 1–33.

‡ Arthur, J. C., 'Report of Botanical Work in Minnesota for the year 1886,' 56 pp., St. Paul, 1887.

§ Ann. Jard. Bot. Buitenzorg, vii. (1887) pp. 74–119 (4 pls.). See Bot. Centralbl., xxxii. (1887) p. 170.

the Hymenophyllaceæ and that of Mosses. He regards the primitive form of both to be a filiform protonema bearing directly sexual organs of both kinds; the original function of the leaves being simply to serve as a protecting envelope. The Hymenophyllaceæ would therefore be the archaic type of Ferns.

Dehiscence of the Sporangium of Ferns.*—Miss F. M. Lyon describes the dehiscence of the sporangium of *Adiantum pedatum* as always taking place along a definite line across the side of the sporangium. This line is always determined by the presence of two narrow and elongated cells with lignified walls opposite the annulus and about midway between its end and the stalk, between which the fissure commences. These "lip-cells," the occurrence of which appears hitherto to have been overlooked, were observed also in a number of other species. The authoress suggests that their presence may have an important bearing on the causes which produce the dehiscence.

Heterophyllous Ferns.†—Herr K. Goebel points out that the usual statement that in the heterophyllous species of *Polypodium* (*P. Willdenowii*, *rigidulum*, and *quercifolium*), one form of frond is sterile and the other fertile, is incorrect; both forms being fertile. The so-called fertile fronds are pinnatifid, long-stalked, and deep-green, and very soon die down to the rachis; the "sterile" fronds, on the other hand, are sessile, cordate, and convex below, so as to form an open "niche" above; they very soon lose their green colour, and wither away with the exception of a framework formed of the veins. The purpose of these leaves appears to be the collection of humus into which the roots of the fern penetrate, thus enabling them to obtain nutriment where otherwise it would be impossible. In *Polypodium Heracleum*, both functions, assimilation and the accumulation of humus, are performed by the same fronds, all having the same form with strongly dorsiventral structure; the base of the leaf forms the "niche," the ribs of the frond the framework for the collection of humus. Leaves of the same kind occur in some epiphytic orchids, as *Bolbophyllum Beccarii*.

The same explanation is offered of the heterophylly of the "elk's-horn fern," *Platycerium grande* and *alcicorne*. The branched fronds serve for the purpose of assimilation, while the intermediate, sessile, unbranched, reniform fronds serve both to retain moisture, and to accumulate humus. At the base of these leaves is a strongly developed aquiferous tissue. Many epiphytic ferns, such as *Drymoglossum*, have similar receptacles for water. In *Polypodium sinuosum* and *patelliferum*, the hollow stem serves as an abode for ants; and the same is the case with the hollow pseudobulbs of some orchids. Organs of secretion occur in both kinds of fronds of *P. quercifolium*.

Characeæ.

New Species of Characeæ.‡—Dr. T. F. Allen describes and figures the following new species:—*Nitella Muthnatæ* from Muthnata Island in the Feejee group; *Tolypella Macounii* from Niagara river, and *Nitella Morongii* from Nantucket. The *Tolypella* is especially noteworthy from

* Bull. Torrey Bot. Club, xiv. (1887) pp. 180–3 (4 figs.).

† Ann. Jard. Bot. Buitenzorg, vii. (1887) pp. 1–21 (1 pl.). See Bot. Centralbl., xxxii. (1887) p. 165.

‡ Bull. Torrey Bot. Club, xiv. (1887) pp. 211–5 (5 pls.).

the fact that the terminal joints of the fruiting rays are one-celled. No other species has such simple terminals; no species has so little fruit and such imperfectly formed "nests." It is *Nitella*-like in its habit of growth, and slightly incrusted.

Muscineæ.

Transpiration of the Sporophore of Mosses.*—Mr. J. R. Vaizey has confirmed by actual experiment his theory, previously enunciated on anatomical grounds, that the thin-walled strand of tissue in the sporogonium of mosses, to which he applies the term *leptoxylon*, is that which conducts the transpiration current up the seta to the apophysis, the organ of absorption and of assimilation and transpiration. The method adopted was to place the cut ends of the sporogonium in a drop of eosin, which was found to pass up the whole of the seta and enter the apophysis. The species experimented on were *Polytrichum formosum* and *Splachnum sphæricum*.

Vegetative reproduction of a Moss.†—Herr H. Schulze describes a peculiar mode of vegetative reproduction in a variety of *Hypnum* (*Harpidium*) *aduncum*; in the production of terminal buds at the ends of the stem and branches. They were usually surrounded by a few filiform paraphyses, and resembled in structure Schimper's bulbils or gemmules.

Sporogonium of Andreæa and Sphagnum.‡—Herr M. Waldner gives a complete account of the development of these two genera of mosses from the embryo to the mature sporogonium.

New Sphagna.§—Dr. C. Müller proposes the classification of the species of *Sphagnum*, which he reckons at about 120, under the following seven sub-genera, viz.:—(1) *Platysphagnum* (*S. cymbifolia*). Folia squamato-imbricata majuscula, apice rotundato-obtusata, apice plus minus cucullata. (2) *Comatosphagnum* (*S. subsecunda*). Folia dense conferta, ramulos plus minus julaceos sistentia, apice truncata exesa. (3) *Acisphagnum* (*S. cuspidata*). Folia plus minus squamoso-imbricata, laxe disposita, plus minus elongata, apice truncata exesa. (4) *Malacosphagnum* (*S. rigida*). Folia imbricata rigido-patula, apice truncata exesa. (5) *Pycnosphagnum* (*S. acutifolia*). Folia imbricata parva, ramulos tenuissimos sistentia, apice truncata exesa. (6) *Acrosphagnum* (*S. mucronata*). Folia imbricata ovato-mucronata pseudo-mucronata, apice vix bifida. (7) *Acoccosphagnum* (*S. sericea*). Folia parva imbricata sericea mucronata, fibris annularibus carentia.

Of these subdivisions (6) belongs entirely to South Africa and Madagascar; (7) to the Sunda Isles. Dr. Müller then describes as many as thirty new species of *Sphagnum*, nearly all from the southern hemisphere.

Rabenhorst's 'Cryptogamic Flora of Germany' (Musci).—The last two parts of this work (7 and 8), by Herr K. G. Limpricht, are still occupied by the Acrocarpæ. The genus *Campylopus* is completed, and

* Ann. of Bot., i. (1887) pp. 73–4. See this Journal, 1887, p. 122.

† Bot. Centralbl., xxxi. (1887) pp. 382–4.

‡ Waldner, M., 'Die Entwick. d. Sporogone v. Andreæa u. Sphagnum,' 25 pp. and 4 pls., Leipzig, 1887. See Bot. Ztg., xlv. (1887) p. 725.

§ Flora, lxx. (1887) pp. 403–22.

is followed by *Dicranodontium*, *Metzleria*, and *Trematodon*. The family Leucobryaceæ comprises the single species *Leucobryum glaucum*. The Fissidentaceæ comprise *Fissidens* with eighteen species, and the monotypic *Pachyfissidens* and *Octodiceras;* the Seligeriaceæ, *Seligeria* with five species, and *Blindia*, *Trochobryum*, and *Stylostegium*, with one each; and the Campylosteliaceæ two species only, viz. one each of *Brachydontium* and *Campylostelium*. Then follow the Ditrichaceæ, including the genera *Ceratodon*, *Trichodon*, *Ditrichum*, and *Distichium*.

Epiphytic Jungermannieæ.*—Herr K. Goebel describes the contrivances for storing up water in the epiphytic Jungermanniceæ of Java, which are numerous, growing especially on the leaves of ferns and flowering plants along with algæ.

The receptacles for water connected with the auricles are of three kinds:—(1) The two lobes of the same leaf are closely approximate, and form an organ the shape of a pouch or pitcher, as in *Radula*, *Phragmicoma*, and *Lejeunia*. In some species of *Radula* it is but feebly developed, most completely in *Lejeunia*. (2) The lower lobe of the leaf is concave on its morphologically upper side, and forms by itself the receptacle, as in *Frullania* and *Polyotus*. These receptacles are not formed if the supply of water is abundant, clearly showing their purpose. (3) The water-receptacle is formed out of a leaf and the lamella which springs from it, as in *Gottschea* and *Physiotium*. The chamber thus formed is often large and tubular, as in *P. giganteum*. They often form domiciles for insects; but there is no ground for regarding these Hepaticæ as insectivorous. The so-called "tubular organs" of species of *Physiotium* are also receptacles for water.

The epiphytic Jungermanniceæ are sometimes provided with special organs of attachment. Disc-like gemmæ were also found on species of *Radula*, *Lejeunia*, and other genera. Those of *L. Goebeli* spring from a single cell of the leaf. The circular gemmæ of *Radula* stand on a unicellular pedicel.

Metzgeriopsis pusilla, epiphytic on the leaves of *Ophioglossum pendulum*, forms an interesting link between the thallose and foliose Hepaticæ. It consists of a small thallus branching monopodially, and composed of only a single layer of cells. It is propagated non-sexually by gemmæ resembling those of *Lejeunia*, as well as by sexual organs, each female fertile shoot bearing only a single archegonium. There are no amphigastria.

Production of Gemmæ by Fegatella.†—Herr G. Karsten describes the formation of gemmæ on *Fegatella conica*, they not having been previously observed in this genus of Hepaticæ. They were obtained both in natural growth and on cultures in pots, under suitable conditions of moisture and temperature. The gemmæ originate from the midrib of the thallus, and either from the lowest layer of cells or the lowest but one when the lowest itself has died away. The cells rapidly become filled with starch and chlorophyll, and the gemma acquires a round form and dark-green colour. A great number of rhizoids are produced from its superficial cells. With or without a period of rest, the gemma developes into a new individual, the first cell-divisions being in the

* Ann. Jard. Bot. Buitenzorg, vii. (1887) pp. 21–66 (8 pls.). See Bot. Centralbl., xxxii. (1887) p. 167.

† Bot. Ztg., xlv. (1887) pp. 649–55 (1 pl.).

merismatic portions of the growing point at right angles to the longer axis of the gemma.

Attempts to produce similar gemmæ in *Preissia commutata* and *Reboulia hemisphærica* were without result.

Algæ.

Plasmolysis of Algæ.*—Dr. J. M. Janse records the interesting fact that the protoplasm of the living vegetable cell is permeable to dilute solutions of mineral salts (potassium nitrate and sodium chloride) and of cane-sugar. The experiments were made both on a salt-water alga, *Chætomorpha ærea*, with which also *Lomentaria*, *Ulva*, and *Dictyota* agree in this respect, and on a fresh-water alga, *Spirogyra nitida*. In all these instances the plasmolysis, which had at first set up with the solutions named, completely disappeared after two hours. After four days the filaments had regained their previous turgidity; the terminal cells being swollen to double their original size by the bulging of the transverse cell-walls, without any cell-division taking place.

Choristocarpus tenellus.†—Herr F. Hauck describes this very rare alga, gathered on *Dasya elegans*, on the island of St. Catherine, off the coast of Istria. The so-called sporangia with transverse septation he has determined to be gemmæ corresponding to those of *Sphacelaria*. One kind only of zoosporangium was found, the multilocular, on separate individuals.

New Fresh-water Floridea.‡—Herr M. Möbius describes a hitherto undescribed fresh-water alga found growing on the leaves of *Aneura pinnatifida*. It consists of dichotomously branched filaments of a red, violet, or greenish colour, springing from cushion-like masses. Although presenting analogies to *Chantransia*, its systematic position cannot at present be ascertained. Cystocarp-like structures were observed, but their exact nature could not be determined.

Lemanea.§—Herr F. Ketel corrects one or two points in Sirodot's description of the anatomical structure of this genus of algæ. The thallus grows by means of an apical cell, from which segments are cut off by walls placed at right angles to its direction of growth. Within each segment two walls, curved in the form of a watchglass, which lie in the direction of the growth in length, first of all separate two opposite lenticular cells. By two further transverse septa a "central cell" is formed, surrounded by peripheral cells. The central cell becomes a member of the central axis, the four peripheral cells develope into the "supporting cells" ("ramification cruciforme"); the hollow cylinder resulting from their further divisions. The thallus may therefore be regarded as composed of a central axis with whorls of four branches which coalesce into the cylinder; while in *Batrachospermum* we have free verticillate branching, and only the accessory lateral branches form a cortical layer applied to the central axis. The ooblastema-filaments proceed directly from the impregnated oosphere; Sirodot does not clearly

* Bot. Centralbl., xxxii. (1887) pp. 21–6.

† Hedwigia, xxvi. (1887) pp. 122–4 (1 pl.).

‡ Versamml. Deutsch. Naturf. u. Aerzte, Wiesbaden, Sept. 21, 1887. Ber. Deutsch. Bot. Gesell., v. (1887) pp. lvi.–lxiv. (1 pl.).

§ Ketel, F., 'Anatom. Unters. üb. d. Gattung Lemanea,' Greifswald, 1887. See Bot. Ztg, xlv. (1887) p. 779.

distinguish between these fertile branches and the branches which occur in large numbers on the carpogonium-branch before impregnation, and which resemble paraphyses.

Microspora.*—M. E. De Wildeman contends that this genus, formed by Thuret, should be again sunk in *Conferva*. The character on which the author relied for establishing the genus, the peculiar way in which the cell-wall behaves previous to the emission of zoospores, resembling the process called by Gay "encysting," † is not a good generic character, but is rather a peculiar condition which occurs in a number of different genera of algæ.

Some points in Diatom-structure.‡—From observations made with a 1/12 in. oil-immersion lens, Mr. T. F. Smith has come to different conclusions in some respects from those of Messrs. Nelson and Karop,§ as to the structure of the valve of *Coscinodiscus asteromphalos*. He objects to the term "double structure," if it implies that the two areolations are nearly on the same plane. As a matter of fact, each single disc of this diatom has three thicknesses of structure, each differing from the other. There is first the outer membrane, next a layer of hexagonal cells, and then an inner plate of so-called eye-spots. In *C. centralis*, what Nelson and Karop have figured as fine perforations are, according to Mr. Smith, little bosses standing out from the outer membrane. A similar structure is attributed by the author to *Aulacodiscus Kittonii* and *Triceratium favus*. He does not commit himself to an opinion whether the eye-spots have, in all cases, a closing membrane, but he thinks it clear that they have in some.

In a later paper,‖ Mr. Smith admits that the diatom described by him as *Coscinodiscus centralis* is not the same species as that referred to under this name by Nelson and Karop.

Deep-sea Diatoms.¶—Abbé Count F. Castracane adduces new evidence of the depth of the ocean at which diatoms can live, from an examination of the contents of the stomach of *Echini* and *Holothuriæ*, dredged up from a depth of 2511 to 5274 metres. These contain the remains of diatoms belonging to the genera *Synedra*, *Rhizosolenia*, &c., in such a condition that the author contends they could only have been consumed in the living state.

Fossil Marine Diatoms from New Zealand.**—Messrs. E. Grove and G. Sturt publish the results of their examination of a fossil marine diatomaceous deposit from Oamaru, Otago, New Zealand. A very large number of new species are described.

Wolle's 'Fresh-water Algæ of the United States.'††—This work is supplementary to the Rev. F. Wolle's well-known 'Desmidieæ of the United States,' and comprises all the remaining families of fresh-water algæ, except the diatoms. It includes also nine new plates of desmids. The Algæ treated are arranged under three classes: Rhodophyceæ,

* CR. Soc. R. Bot. Belgique, 1887, pp. 92–6. † See this Journal, 1887, p. 277.
‡ Journ. Quek. Micr. Club, iii. (1887) pp. 125–30.
§ See this Journal, 1886, p. 661. ‖ Tom. cit., pp. 163–6 (1 pl.).
¶ Atti Accad. Pontif. Nuovi Lincei, xxxviii. (1886) pp. 46–7. Cf. this Journal, 1885, p. 498. ** Journ. Quek. Micr. Club, iii. (1887) pp. 131–48 (5 pls.).
†† Wolle, Rev. F., 'Fresh-water Algæ of the United States, exclusive of Diatomaceæ,' 2 vols., 364 pp., and 151 pls., Bethlehem, Pa., 1887.

Chlorophyceæ, and Cyanophyceæ ; the first and third including each only one order, viz. Florideæ and Schizosporeæ, while the Chlorophyceæ are again divided into four orders, Confervoideæ, Siphoneæ, Protococcoideæ, and Zygosporeæ. The author adopts Hansgirg's view with regard to the polymorphism of algæ, and regards all our present systems of classification as only temporary.

Lichenes.

Glœolichenes.*—Herr K. B. J. Forssell's monograph of this new family of lichens is now published in detail. He defines the class as Ascolichenes with gonidia belonging to the Chroococcaceæ. The symbiosis between the two constituents of the lichen may be indifferent, antagonistic, or mutual. The algal constituent belongs to the genera *Chroococcus*, *Glœocapsa*, and *Xanthocapsa*, possibly also to *Aphanocapsa*, *Glœothece*, and *Microcystis*. The only kind of spore produced by the fungal element is endogenous (ascospores); stylospores have not been observed. The apothecia are either closed or open. The following twelve genera are described in detail, with their species:—*Cryptothele*, *Pyrenopsis*, *Synalissa*, *Phylliscidium*, *Pyrenopsidium*, *Phylliscum*, *Collemopsidium*, *Enchylium*, *Psorotichia*, *Peccania*, *Anema*, and *Omphalaria*.

Gasterolichenes.†—Mr. G. Massee describes under this name a new section of lichens formed by the commensalism of a fungus belonging to the order Trichogastres of Gasterolichenes, with a unicellular alga.

The first example is the fungus known as *Emericella variecolor* Berk., in which the algal constituent is *Palmella botryoides*. The cells of this alga he describes as subglobose or broadly elliptical, varying from 20 to 39 μ in longest diameter, and furnished with a very thick lamellose hyaline cell-wall. From the chlorophyllous portion of the cell a green unseptated filament passes through the cell-wall, and is joined at some distance to a similar filament from another cell, the two forming a common stem, on which several pairs of cells are supported on similar lateral bifurcating filaments. These pairs of cells originate from the fission of a single cell. The alga occupies interspaces in the loose peripheral portion of the base of the fungus, and also passes up into the loose texture of the peridium. The tips of lateral branches of hyphæ are frequently seen closely investing and even penetrating the algal cells.

A second type of Gasterolichenes is furnished by the fungus described as *Trichocoma paradoxa* Jungh. Here the algal constituent belongs to the genus *Botryococcus*, and forms a stratum at the base of the capillitium. The colonies are generally invested with the hyphæ of the fungus. To these Mr. Massee now adds a third hitherto undescribed species, *T. lævispora*.

Action of Lichens on Rocks.‡—Dr. J. Müller makes an interesting note on the weathering action of lichens upon rocks. Little excavations containing the fructifications of lichens are often found on the surface of rocks, especially limestones. Several species of *Polyblastia* have the fructifications deeply buried, and it has been supposed that the lichen gradually ate its way in by the aid of acid secretion. If this were true,

* Nov. Act. R. Soc. Scient. Upsala, xiii. (1887) pp. 1–118. See this Journal, 1886, p. 485.

† Phil. Trans., clxxviii. (1887) pp. 305–9 (1 pl.).

‡ Arch. Sci. Phys. et Nat., xviii. (1887) pp. 490–1. Bull. Soc. Murithienne du Valais, 1887.

the comparatively large apothecia sometimes found beneath the surface ought to be connected with the exterior by some chimney-like tube. This is not the case. They appear to grow from the inside outwards, not from the outside inwards. The fact is that a large number of excessively fine gonidia-bearing hyphæ insinuate themselves in the rock, and ramify under the outer pellicle of rock as the roots of grass in a meadow. The system can be demonstrated by dissolving away the rock in hydrochloric acid, which leaves the spreading hyphæ and their gonidia intact. This internal thallus is of great importance as a silent factor in dynamical geology, aiding very powerfully the weathering of rock surface.

Lichens on unusual substrata.* — Herren Hegetschweiler and Stizenberger give a list of fifteen species of Lichen gathered on serpentine, nine on the stem of the grape-vine (besides two mosses *Orthotrichum affine* and *Amblystigium riparium*), and eighteen on the deciduous bark of young plane trees.

Fungi.

Accumulation and Consumption of Glycogen by Fungi.†—Dr. L. Errera adduces further evidence of the fact that glycogen plays the same part in fungi that starch does in other plants. In young Ascomycetes (*Peziza vesiculosa*) the glycogen is distributed through the whole tissue, the hyphæ and pseudoparenchyma being completely filled by it. As soon as the hymenium is developed the glycogen pours into it, and later is found at work entirely in the asci. When the fructification is ripe, the glycogen has again completely disappeared, reserve-substances, especially of an oily nature, being stored up in the ascospores. The same phenomenon of the disappearance of the glycogen takes place during the very rapid growth of the stalk of *Phallus impudicus*.

The glycogen of fungi is not formed, like the starch of other plants, from the free carbon dioxide of the atmosphere, but out of previously existing organic carbon compounds, especially the products of decomposition of other food materials.

Function of Cystids.‡—Dr. R. v. Wettstein has investigated the structure and function of those organs of Hymenomycetes known as cystids. Various functions, such as those of artheridia, have been ascribed to them. Brefeld showed that they develope (in *Coprinus stercorarius*) from rudimentary basidia, and have an external protective function in the development of spores. They are props to keep the lamellæ apart.

Wettstein has been led to corroborate and extend Brefeld's conclusions. The cystids are homologous with basidia. Their systematic importance has been exaggerated. They are always closed. There are two kinds: (*a*) with free, (*b*) with fixed extremities. The latter may be fixed to another cystid, or may have penetrated into the tissue of adjacent lamellæ, or may have united with the palisades of other lamellæ. As to function: (1) they force the lamellæ apart, making room for spore-development; (2) they prevent the delicate membranous moist lamellæ from adhering together; (3) they may also bind lamellæ together. They seem definable as very passive overgrown non-reproductive basidia.

* Flora, lxx. (1887) pp. 430–1.

† Versamml. Deutsch. Naturf. u. Aerzte, Wiesbaden, Sept. 21, 1887. Ber. Deutsch. Bot. Gesell., v. (1887) pp. lxxiv.–viii. Cf. this Journal, 1886, p. 833.

‡ SB. Akad. Wiss. Wien, xcv. (1887) pp. 10–21 (1 pl.).

Rhizomorpha subcorticalis of Armillaria mellea.*—M. J. de Seynes states that, in the initial stage of its development, the *Rhizomorpha subcorticalis* appears as a white fibrous membrane more or less flabelliform, and agrees with Leveille's definition of the hymenoid mycelium of *Armillaria mellea*. The author further states that he has observed in certain cases a tendency of the extremity of the rhizomorph to divide into lobes, and these are easily detached from the wood on which the fungus is growing.

In conclusion, the subject of these observations is described as a mixed organ representing not only a condensed membranous mycelium, but sterile, deformed, and flattened receptacles. A few lines are also added on its mode of phosphorescence, which is stated to be exclusively nocturnal.

Uredineæ.†—Herr P. Dietel enters into several points of comparative anatomy in the Uredineæ. One of the more important features of variation within the family is in the teleutospores, while very little variety is exhibited by the uredospores or æcidiospores. The æcidia of *Gymnosporangium* differ from those of the other genera in not being saucer- or cup-shaped, but comparatively long flask-shaped structures.

The greatest point of variability in the teleutospores is their size, and the number of cells of which they are composed, this varying even within the same genus. In addition to the normal bicellular teleutospores, unicellular spores often occur, which have been termed "mesospores," from an idea that they are intermediate structures between teleutospores and uredospores. Tulasne, on the other hand, regards them as having arisen by the abortion of the lower cell of the teleutospore, thus exhibiting the affinity of *Puccinia* with *Uromyces*, the latter being degraded representatives of the former. Herr Dietel, while agreeing with this view on the whole, thinks it more probable that *Puccinia* has sprung from *Uromyces* by progressive development.

The teleutospores also vary greatly in their form; and this is sometimes the case even in the same species, especially where it occurs on several different hosts. The occurrence, in certain species of *Puccinia*, of teleutospores consisting of three or more cells has been thought to indicate a transition to the genera *Phragmidium* and *Triphragmium;* but the author considers that this is rendered improbable by the very different phenomena of germination exhibited by the spores of these two genera. In *Puccinia* germination takes place by a single pore at the upper end of each cell; in *Phragmidium* by several pores in the equatorial zone of each cell. The nature of the surface of the outer membrane of the teleutospore is also variable, especially in *Uromyces* and *Puccinia;* the two constituent spores may differ from one another in this respect, or may be alike. Great difference is also exhibited in the colour of the spores.

The Uredineæ are generally regarded as most nearly allied to the Ascomycetes; but the homology of the different kinds of spore is attended with difficulties. Schröter regarded the teleutospores as homologous to the asci. The frequent appearance of spermogonia without æcidia before the uredo-generation can only be explained by the abortion

* Bull. Soc. Bot. France, xxxiv. (1887) pp. 286–7.

† Bot. Centralbl., xxxii. (1887) pp. 54–6, 84–91, 118–21, 152–6, 182–6, 217–20, 246–50 (1 pl.).

of a previously existing æcidio-generation; and from this it would appear to follow that the æcidio-form, and not the teleuto-form, is the original one. The author thinks it must be assumed that originally one and the same mycelium had the power of producing both teleutospores and æcidiospores; and that the distinction of the two generations originated in the alternations of climate; and the occurrence or absence in any species of the uredo-generation depends, in the same way, on its adaptation to the climatal conditions in which it is found. The most essential difference between the Uredineæ and the Ascomycetes lies in the capacity of the former to produce sporidia, which do not fail in any known species, and must therefore be regarded as the most essential member in the cycle of development.

All three generations may occur on the same host in the course of a year, or they may be confined to different hosts. In the heterœcious species the particular host on which the teleuto-form or æcidio-form will develope depends in no way on its systematic position, but on the facilities presented for the spread of the spores. Autœcious Uredineæ can hibernate in the uredo-form. In all probability it is the teleutospore-generation that has migrated from its original host to a different one.

Grape-disease—Comothyrium diplodiella.*—M. E. Prillieux has come definitely to the conclusion that *Comothyrium diplodiella* is a true parasite, and not merely saprophytic. Professor Pirotta, of Rome, allowed ripe spores to germinate in spring-water, and infected perfectly healthy grapes with them. The disease showed itself in four to six days. M. Fréchon corroborated this, and M. Prillieux has also satisfied himself by experimental inoculation that the fungus is truly parasitic.

New Disease of Lemons.†—Sig. G. Gasperini describes a new disease exceedingly destructive to the lemon-crop in Italy, spreading with very great rapidity, and entirely destroying the fruit, which it causes to fall, and to which it gives a nauseous smell. He finds it to be caused by the mycelium of several Hyphomycetous fungi, of which the following species are described as new, and their diagnoses given, viz.:—*Aspergillus violaceo-fuscus*, *A. elegans*, and *A. variabilis*. On the surface of the lemons was also found a species of *Saccharomyces*, which he calls *S. Citri*, consisting of oval, elliptical, or cylindrical cells 3–6·5 μ long by 1–2 μ broad, united into colonies which branch in a variety of ways. They contained from one to three very minute spores, and were readily cultivated on dilute sterilized lemon-juice.

New Pythium.‡—Herr W. Wahrlich proposes the name *Pythium fecundum* for a new saprophytic species found in a stream springing from the Rhone Glacier. It presents in some respects a transitional form between the Peronosporeæ and the Saprolegnieæ. The zoosporangia are 2 μ broad, 120–160 μ long, and scarcely distinguishable from the ordinary hyphæ; the zoospores are reniform, 4 μ wide by 6 μ long, and with two cilia on their concave side. The oogonia are of two kinds; in those first formed each oogonium is impregnated by one or two antheridia formed in close proximity to the oogonium. The second kind are sometimes produced on the same branch as the first, but later. These are

* Comptes Rendus, cv. (1887) pp. 1037–8.
† Atti Soc. Tosc. Sci. Nat., viii. (1887) pp. 315–41.
‡ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 242–6 (1 pl.).

double the size, and break up into two or three daughter-cells, each of which is an oogonium capable of impregnation. When not impregnated, the oogonium puts out prolifications which develope into ordinary vegetative hyphæ.

Chytridiacea parasitic on Diatoms.*—Under the name *Ectrogella Bacillariacearum* Herr W. Zopf describes a parasite which attacks species of *Synedra* and *Pinnularia*. Its effect is first manifested by an alteration in the shape and position of the chlorophyll-bands. They recede from the walls, contract in direction of their length, and become closely applied to the parasites. At the same time the nucleus is dissolved and the protoplasm contracts. Later on, in consequence of the pressure exercised by the parasites, the valves fall asunder. The sporangial fructification of *Ectrogella* determines its place among the Ancylisteæ; it bears the same relation to *Ancylistes* as *Olpidiopsis* to *Myzocytium*.

Cohn's 'Cryptogamic Flora of Silesia.'†—The last contribution to Herr J. Schroeter's monograph of Silesian fungi in Cohn's 'Cryptogamic Flora of Silesia' is devoted to the orders Protomycetes, Ustilagineæ, Uredinei, and Auriculariei. A full account is given of the life-history of fungi belonging to these orders. Protomycetes include the two genera *Protomyces* and *Endogone*. The Ustilagineæ are divided into three families, viz.:—Ustilaginacei (*Ustilago, Sphacelotheca, Schizonella*, and *Tolyposporium*); Tilletiacei (*Tilletia, Urocystis, Entyloma, Melanotænium, Tuburcinia, Doassansia*); and Thecaphorei (*Schræteria, Thecaphora, Sorosporium*), with several doubtful genera. The Uredinei comprise five families, viz.:—Pucciniei (*Uromyces, Puccinia*); Phragmidiei (*Trachyspora, Triphragmium, Phragmidium*); Endophyllei (*Endophyllum*); Gymnosporangiei (*Gymnosporangium*); and Melampsorei (*Melampsora, Melampsorella, Calyptospora, Coleosporium, Chrysomyxa*, and *Cronartium*. The Auriculariei comprise the single family Auriculariacei (*Stypinella* n. gen. and *Platyglœa* n. gen.). The following new species are described:—*Ustilago major, Uromyces alpinus, U. minor, Puccinia Cirsii lanceolati, P. Crepidis, P. tenuistipes, Platyglœa fimicola*, and *P. effusa*.

Protophyta.

Microchæte.‡—Under the name *M. striatula* l'Abbé Hy describes a new species of this genus, found among *Sphagnum* in turf-bogs. It forms an interesting link of connection between the older species on which M. Thuret founded the genus, and the more recently discovered *M. diplosiphon* Gom. M. Hy agrees with Bornet in regarding *Microchæte* as belonging to the Scytonemaceæ, of which it constitutes the most simple type without any appearance of branching.

Vibrio from Nasal Mucus.§—Dr. E. Weibel finds that there occurs in the mucosa of the posterior nares a vibrio, the presence of which is not apparently associated with a pathological condition. The bacillus is curved, and about as thick as that of anthrax, the length varying from 2–5 times the thickness. The degree of curvature is very variable, there

* Zopf, W., 'Zur Kenntniss der Phycomyceten.' See Mr. G. Karop in Journ. Quek. Micr. Club, iii. (1887) p. 115 (1 pl.).

† Schroeter, J., in Cohn's Kryptogamen Flora v. Schlesien, Bd. iii. Lief. 3, Breslau, 1887. See Hedwigia, xxvi. (1887) p. 173.

‡ Morot's Journ. de Bot. i. (1887) pp. 193–8 (3 figs.).

§ Centralbl. f. Bacteriol. u. Parasitenk., ii. (1887) pp. 465–9 (4 figs. of a pl.).

being gradations from a semicircle down to a straight line. The bacilli are aggregated into groups, and do not form continuous threads. About individual rods an unstained periphery is evident, but the possession of a capsule is not conclusively demonstrable. Pure cultivations were obtained by breeding, first in bouillon, then in gelatin, and afterwards isolating on gelatin-plates. On the plates the colonies became visible on the third day, and by the fifth attained a diameter of 0·3 mm.; by the next day their size was nearly doubled. In tube cultivations the colonies spread along the inoculation track, there being no surface development and no liquefaction of the medium. In agar the development was similar but more luxuriant. On potato no growth occurred. The morphological variations are manifold and complicated, although the fundamental form is a bent rod. In bouillon it almost always occurs as single rods, the ends of which stain deeply, the central part remaining uncoloured. Such forms therefore simulate diplococci, and raise a suspicion of spore-formation. Cultivated in agar or gelatin, single rods occur, but most frequently the individual elements are united to form chains, which are most perfect in the agar. Staining is easily effected with gentian violet and decoloration by Gram's iodine. Weak spirit (1:3) dissolves out the dye from the stained medium, and leaves the bacilli still coloured. The formation of spores could not be proved. In hanging drops only Brownian movements were perceived. The author has repeatedly made pure cultivations of the vibrio from his own nasal mucus, but declines to give a definite opinion as to its general frequency. Subcutaneous inoculations produced no effect on mice.

Two kinds of Vibrios found in decomposing Hay Infusion.*—Dr. E. Weibel obtained from rotting hay infusion two kinds of vibrio by means of the attenuation method. A needleful of the fluid was diluted with so much sterilized water that in each drop only a very few germs were included; from this a series of test-tubes filled with sterilized hay infusion were inoculated. In two tubes vibrios predominated. From these gelatin-plate cultivations were made, and two kinds of vibrio successfully developed. These differed in size, and are distinguished as hay vibrio α and hay vibrio β. The larger kind, vibrio α, is a bent rodlet about 3 μ long; the thickness is about one-fifth of the length. Owing to the ends diminishing in thickness, a crescent-shaped form results, and in the centre of this is a bright spot. Two individuals frequently unite to produce an S-like form, more numerous combinations being less common; but such may appear after eight days' cultivation in bouillon or agar.

Vibrio β is about 2 μ long, and about as thick as the tubercle bacillus. Double-comma forms are very frequent, and in some preparations the rule. On gelatin plates the two kinds grow slowly, but α quicker than β. Colonies of α attain in three days a diameter of 0·2–0·3 mm., and in six days about 0·6 mm. Under a low power ($\times$ 80) and with reflected light, they appear as circular yellowish-brown discs, and on the third or fourth day as dark rings round about a central point. The colonies of vibrio β never exceed 0·3 mm. in diameter. In neither case is the gelatin liquefied. In gelatin both kinds grow along the inoculation track, and also show a slight growth on the surface, but the whole of the surface is never overgrown. In agar the inoculation

* Centralbl. f. Bacteriol. u. Parasitenk., ii. (1887) pp. 469–72 (2 figs. of a pl.).

track is little affected, but over the surface development takes place copiously, vibrio α spreading in a dirty whitish-yellow layer, beneath which the agar mass for a depth of 1–2 mm. is clouded. Vibrio β produces a similar crust, but the underlay is dry, and it is impossible to remove a specimen without taking up also the agar substance. On potato both kinds thrive well. Vibrio α forms in two days a luxuriant slimy layer of a yellow-red colour, which gradually darkens to chocolate. Vibrio β produces a thin dirty brownish-green overlay, which is removed for examination with difficulty. The potatoes breeding vibrio α develope a strong ammoniacal odour, but with vibrio β this occurs but slightly or not at all. Both stain well with anilin dyes, especially with gentian-violet. In hanging drops both varieties show lively movements.

Phosphorescent Bacteria from Sea-water.* — Dr. O. Katz has isolated three groups of micro-organisms, which are capable of cultivation in various nutrient media, and which by transference to marine animals (fish, crustaceans) and to sea-water produce phosphorescence.

(1) *Bacillus smaragdino-phosphorescens*, obtained from dead marine fish, is a short thick rod about 1 μ wide and about double as long as wide. The ends are rounded off. It is not motile or flagellated. When stained with anilins the peripheral parts only are dyed, a central spot or "vacuole" remaining uncoloured. It grows in small colonies on gelatin without liquefying the medium. It develops best at a temperature of 20° C. or a little higher, and then emits a "wonderful emerald-green" light. Grown at 13–15° C. development is slower and the light is less intense.

(2) *Bacillus argenteo-phosphorescens* was obtained from sea-water at Elizabeth Bay, Sydney. On gelatin, after having been mixed with ten drops of sea-water, there would appear, among a considerable number of other colonies, not more than two of these luminous colonies. It is a slender rod, tapering at the extremities and commonly slightly curved. It is about 2·5 μ long, and about three times as long as broad. It is motile, but forms no filament. The best stains were anilin-fuchsin and anilin-gentian-violet. The colonies do not liquefy gelatin, but spread over it more than those of number 1. It grows best between 14° and 23° C., and within this range shows the greatest luminosity. The emitted light is of a mild silvery appearance.

(3) *Bacillus cyano-phosphorescens* was obtained from sea-water at Little Bay, Sydney. It is a straight rod about 2·6 μ long, and about $2\frac{1}{2}$ times as long as broad. The ends are rounded off. It is motile, and is often found as diplo-bacillus, but not often in chains. These are commonly bent, attaining here and there a considerable length. It stains well with alkaline methylin-blue, but a small central portion remains uncoloured. It grows rather slowly in and upon gelatin, which is gradually liquefied by it. It develops better on agar, where after a comparatively short time it forms a substantial greyish-white sticky layer. The optimum of growth and luminosity lies between 20° and 30° C., but a lower temperature is not unfavourable. The colour of the light emitted has a decidedly bluish tint. The intensity lies between those of I. and II. The author proposes to publish further details later.

In some further remarks on the phosphorescent bacteria,† Dr. Katz describes three additional kinds.

* Proc. Linn. Soc. N. S. Wales, ii. (1887) pp. 331–6.

† Abstr. Proc. Linn. Soc. N. S. Wales, 1887, p. v.

(1) *Bacillus argenteo-phosphorescens liquefaciens*, obtained from sea-water at Bondi; its cultures, liquefying gelatin, emit in the dark a silvery light, which, however, is the weakest of the six kinds hitherto found; (2) *Bacillus argenteo-phosphorescens* II., derived from a luminous piece of a small squid (*Loligo*), and, at the same time, from luminous pieces of the Sydney gar-fish (*Hemirhamphus intermedius* Cant., *H. melanochir* Cuv. and Val.); (3) *Bacillus argenteo-phosphorescens* III., from the squid already mentioned. Neither of the latter micro-organisms causes liquefaction of the gelatin. They give off in the dark a handsome silver light, much more intense than that of the first-mentioned, but resembling that of the previously exhibited *Bacillus argenteo-phosphorescens* (now to be designated I.). From this latter Nos. II. and III. distinctly differ.

Lectures on Bacteria.*—The second improved edition of Prof. A. De Bary's Lectures on Bacteria has been translated into English by Mr. H. E. F. Garnsey, and revised by Prof. I. B. Balfour; it will be very useful as a general view of the subject to all who are interested in these organisms.

* 'Lectures on Bacteria. By A. De Bary. Authorised translation by Henry E. F. Garnsey. Revised by I. B. Balfour.' Oxford, 1887.

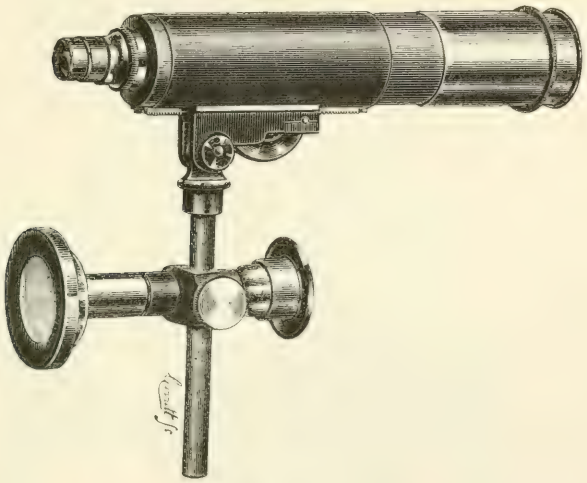
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Collins's Aquarium Microscope.—Mr. C. Collins's Aquarium Microscope (fig. 1) differs from all other forms in that it is applied to the side of the aquarium itself. This is accomplished by making use of a sucker apparatus. The head of the sucker is shown on the left of

Fig. 1.



the drawing, with an indiarubber ring surrounding a central piston. The ring is applied to the glass surface of the aquarium, and the air is exhausted by screwing round the head of the piston seen on the right. Two turns are sufficient to fasten the sucker securely. The rod to which the support of the body-tube is attached passes through the sucker-arm, and can be clamped at any height desired.

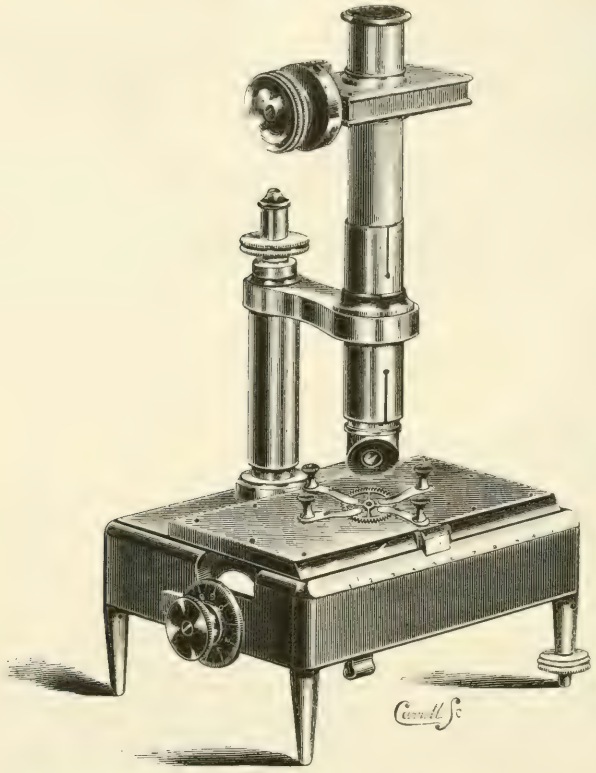
Golfarelli's Micrometric Microscope for Horologists.—This Microscope (fig. 2), made by the "Officina Galileo" of Florence, after the design of Prof. I. Golfarelli, is intended for the use of clock- and watch-makers, enabling them to ascertain, for instance, that the teeth of chronometer and duplex escapement wheels are regularly cut.

The upper part of the Microscope is screwed to a metal stage 5 in. × 4 in., supported on four feet, and having a graduated scale on its front side. In a wide groove in the stage slides a metal plate, with four spring clips to hold the object examined. The clips can be variously applied in fourteen different holes. The plate is moved by a

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

fine screw, which extends beneath the stage for its whole length, and is actuated by the milled head on the right. To this is attached a graduated disc, which reads against a fixed index, the movable plate having also an index. Over the front of the objective is a plane mirror of polished silver, with a central aperture through which the object is

Fig. 2.

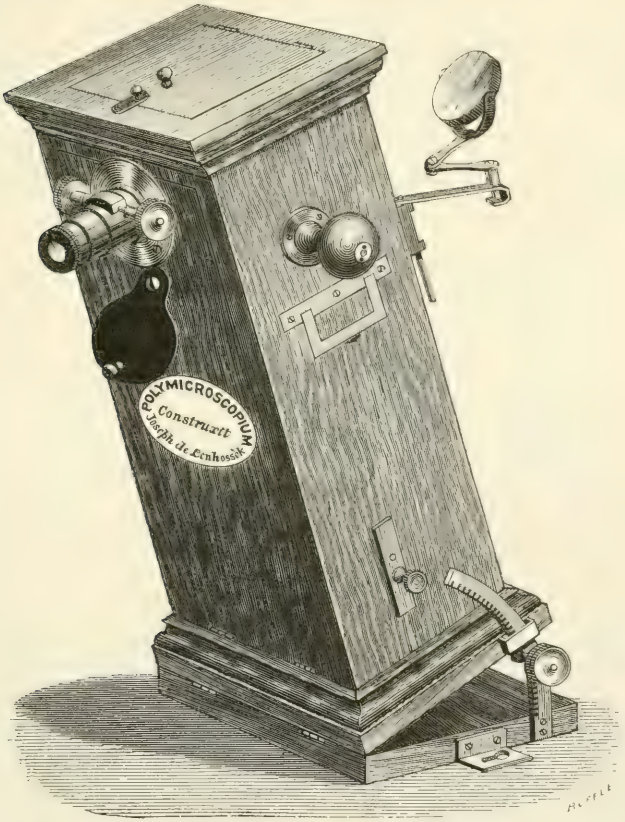


viewed. The mirror being inclined at 45°, reflects the light upon the object on the stage, which is always viewed as an opaque object. The mirror rotates in a collar socket to vary the illumination. There is a fine-adjustment screw (usual Continental form) at the top of the pillar, and a screw eye-piece micrometer forms part of the body-tube. For levelling the instrument one of the feet has a screw by which it can be lengthened or shortened.

Lenhossék's Polymicroscope.—Dr. J. v. Lenhossék has applied the principle of the revolving stereoscope to the Microscope in a very ingenious manner. The instrument is shown in perspective in fig. 3, in profile in fig. 4, and in section in fig. 5. The essential feature consists in an endless band M M (fig. 5) turning on the upper and lower axles K L, and carrying 60 ordinary 3 × 1 in. slides, N. The slides lie horizontally, but as each slide comes to the top it stands vertically, and the object is observed through the opening H, in the side of the box A, by the Micro-

scope I, which is necessarily of somewhat low power, and has a focal distance of 53 mm. The endless band is moved by two handles at the sides of the outer box, which turn the upper axle. The slides can be illuminated by direct light through the opening F, in the opposite side of the box, or by the mirror R, shown in figs. 3 and 4. The Microscope is focused by the milled head at *q*. The slides can be placed in position

Fig. 3.



by raising the top of the box B (fig. 5), or if a more extensive inspection of the interior of the box is required both front E and back G (hinged at the bottom at *e* and *g*) can be turned away as shown in fig. 5.

The manner of fixing the slides is shown in fig. 6, A from in front, B from above. *a a* in the one fig. and *b b* in the other are the two spring jaws which hold the slides firmly in position. A disc with four notches is attached to one end of the upper axle, and a spring falling into a notch, indicates when a slide is exactly vertical.

An arc-piece with rack and pinion (B *c*, fig. 4), enables the whole instrument to be inclined to suit the convenience of the observer.

The lenses can be attached to a special stand, and used as an ordinary Microscope.

With the Microscope Prof. Lenhossék sent a portfolio of manuscript

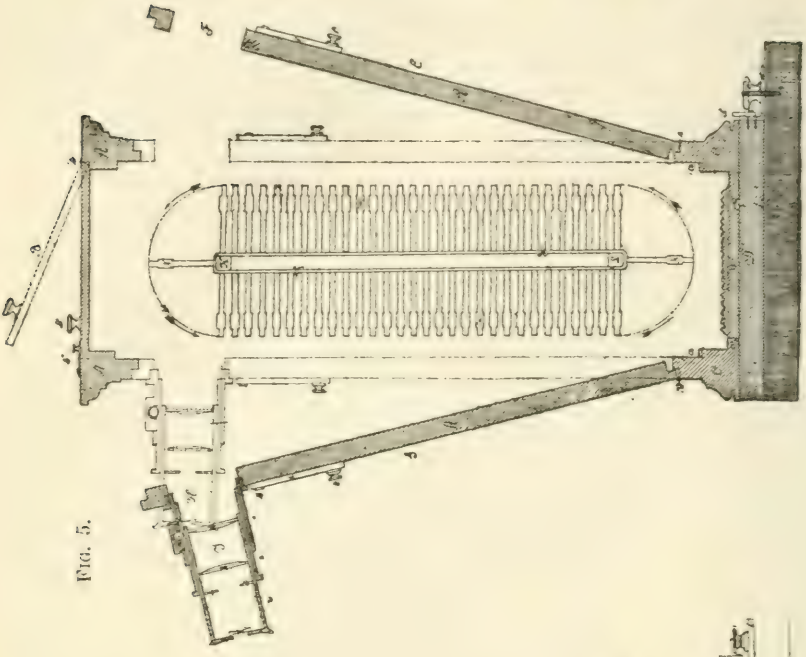


FIG. 5.

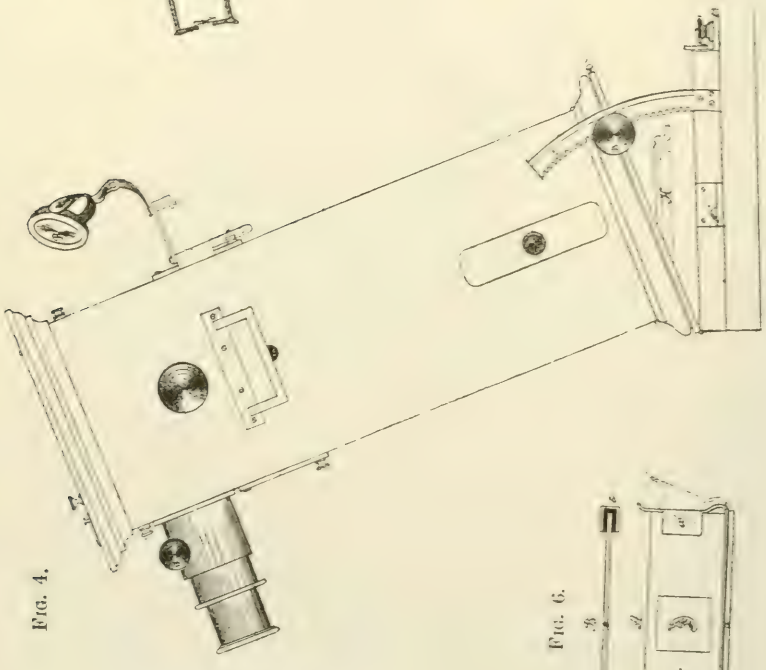


FIG. 4.

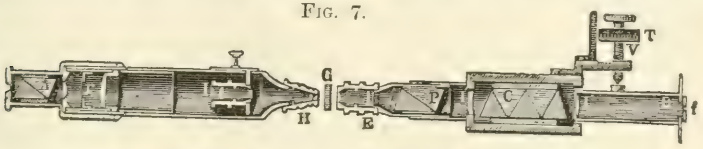
FIG. 6.

and drawings, giving the most elaborate and complete account that perhaps has ever been given of any Microscope.*

Prof. Lenhossék recommends the Polymicroscope especially for a continuous series of objects.

Dufet's Polarizing Microscope.†—This instrument (figs. 7–9) was designed by M. H. Dufet to show the interference figures of crystalline

Fig. 7.



fragments, and to allow of the accurate measurement of the axial angle for different colours of the spectrum. G, fig. 7, is the plate of crystal

Fig. 8.

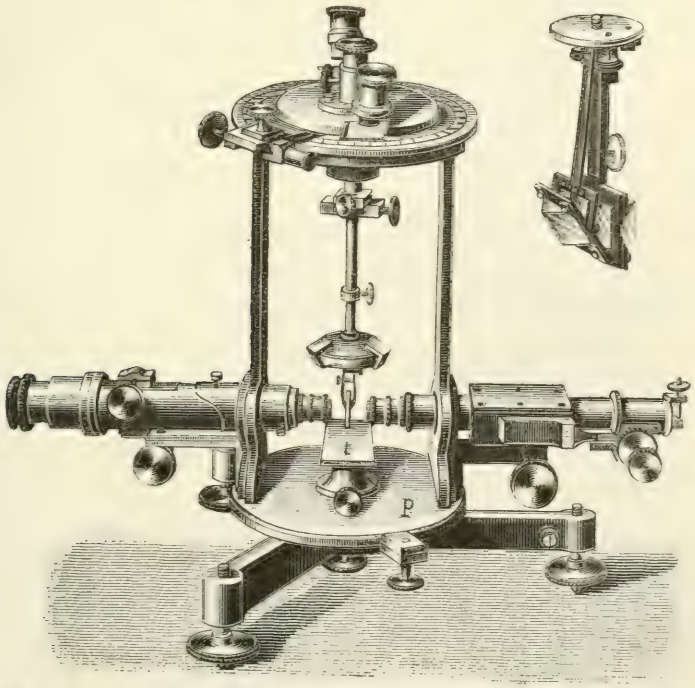


Fig. 9.

which receives a pencil of convergent light polarized at P. The rays which traverse the objective H (No. 9 of Nachet) form at its principal focus the real image of the isochromatic curves; and these are examined by a Microscope composed of the objective I (No. 0 of Nachet), and of

* Cf. also 'Ein Polymikroskop von Dr. Joseph von Lenhossék,' 25 pp., 1 phot., and 2 pls., 8vo, Berlin, 1877 (from Virchow's Arch. f. Pathol. Anat. u. Physiol., lxx.).

† Journ. de Physique, v. (1886) pp. 564–84. Bull. Soc. Franc. de Minéral., ix. (1886) pp. 275–81 (2 figs.).

the eye-piece r with cross wires; the analyser is at A. The image is much improved by the use of microscopic objectives (of which the principal focal surfaces are practically plane), instead of simple lenses. The instrument is focused by moving the objective I and then shifting the eye-piece. The apparatus for concentrating the light consists of a microscopic objective E placed behind a nicol. To use rays of any required refrangibility, a direct-vision spectroscope is employed. The collimator B is moved by a micrometer screw V with divided drum T. The rays, after traversing the prism C and the lens l, form a real spectrum at the principal focus of the objective E. The isochromatic curves are then projected upon the spectrum, and a movement of V brings the different colours in succession into the field; the graduation on the drum will, by previous experiment, give the exact wave-length of the light corresponding to any position of the collimator.

Fig. 10.

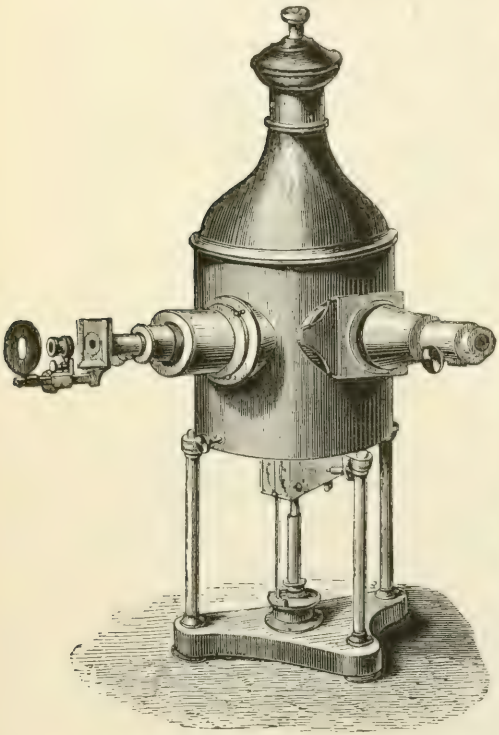


Fig. 8 represents in 1/5 the natural size the apparatus used for the measurement of axial angles; it is practically that of von Lang. The crystal fragment is held in a spring clip with spherical and rectilinear adjustments, and moves under a divided circle reading with verniers to 20″. Measurements in oil can as usual be made by the help of the small stage t below the crystal. This apparatus may also be used to measure indices of refraction by the method of total reflection; for this purpose the spectroscope is removed, and the clip is replaced by the two prisms represented half-size in fig. 9, which inclose the section surrounded by a layer of some liquid having a higher refractive index than the section itself. Finally, this part of the apparatus may be used, like the similar Universal Apparatus of Groth, as a Wollaston goniometer.

Duboscq's Projection Microscope.*—M. Duboscq's projection Microscope (fig. 10) is arranged to carry three objectives, two shown in the fig., the third being at the opposite side of the lantern. This enables different magnifying powers to be used by simply turning the lantern round and without having to screw and unscrew the objectives. Electric light is used for the illumination.

* Stein, S. T., 'Das Licht im Dienste wiss. Forschung,' v. (1887) pp. 303–5 (3 figs.). Also 'Die Optische Projektions-Kunst im Dienste der exakten Wissenschaften,' 1887, pp. 94–6 (3 figs.).

Campani's Compound Microscopes.—With reference to the note on pp. 643–4,* we have since found that a figure of a nearly similar Microscope was published in the 'Acta Eruditorum,' Lipsæ, 1686, Tab. x. (pp. 371-2), where it was designated "Novum Microscopium

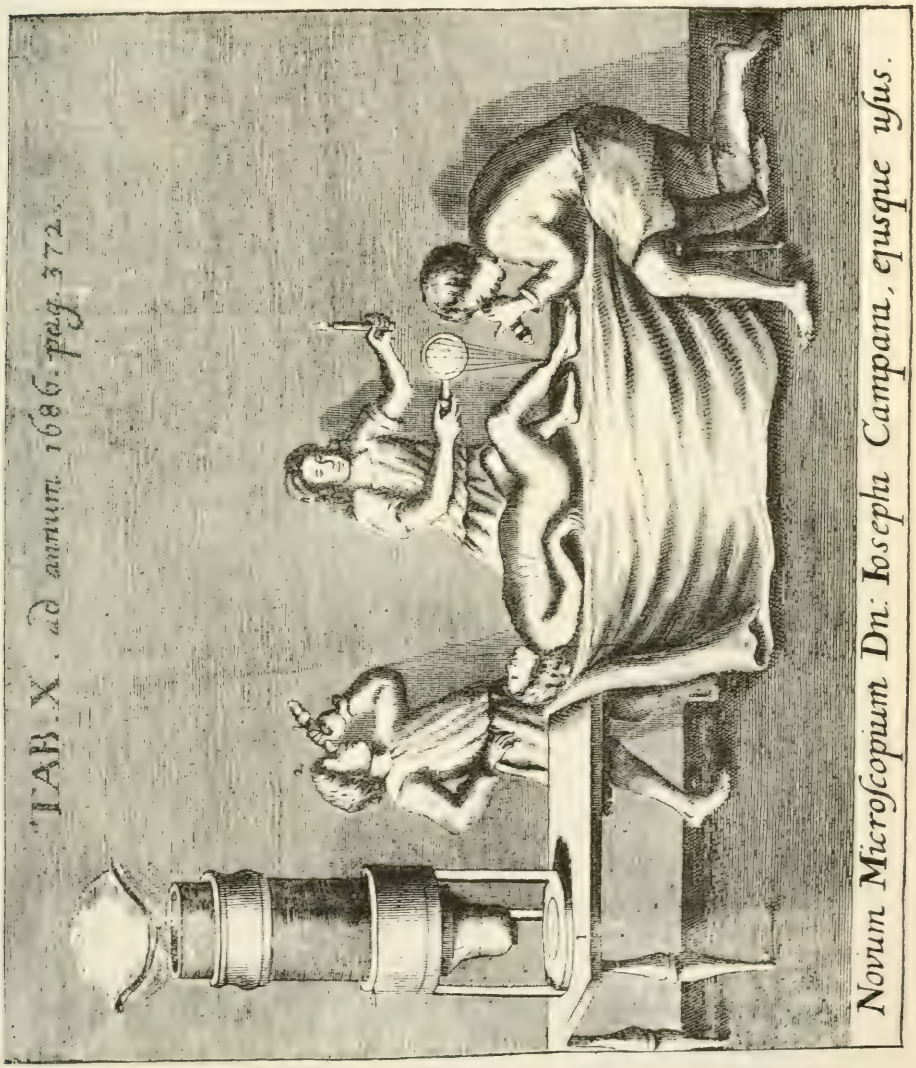


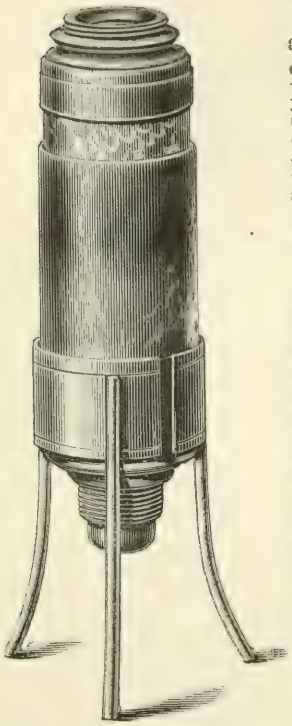
FIG. 11.

Dn: Iosephi Campani, ejusque usus," the figure also showing the employment of the instrument for viewing transparent and opaque objects. This figure was reproduced in the 'Opuscula omnia Actis Eruditorum Lipsiensibus inserta, &c.,' tom. ii., Venetiis, 1740, p. 439.

* See this Journal, 1887, p. 643.

Our fig. 11 is copied from the original. It will thus be seen that our conjecture as to the early date (*ante* 1665) of the construction, based upon the absence of a field-lens, may possibly need qualification in the face of the publication (apparently the first of *this* form of Microscope) in 1686.

Fig. 12.



From various references we have met with, and notably from the paper 'Nvove inventioni di tubi ottici' (a contribution to the 'Accademia Fisico-matematica,' of Rome, in 1686, by—we believe—Ciampini, the then editor of the 'Giornale de' Letterati,' of Rome) Campani's Microscopes appear to have been well known at that date, so well known, indeed, that any resemblances to them in more recent models were at once noted.

Attention may be called to the curious mixture of scales in the drawing. The large Microscope on the left is the same instrument as is represented by the two small ones in the centre and on the right. The artist, it will be seen, has introduced a diagram of an eye above the large Microscope, a proceeding which, although it looks very odd in such a picture, had the useful effect of checking the scale and preventing the instrument from being taken to be of the same proportions as the men who accompany it in the drawing. It will be remembered that it was the blunder of an artist in substituting a man for an eye, that led to the ludicrous misinterpretations of Schott's Microscopes on which we commented in this Journal, 1887, p.148.

In a more recent visit to Italy than that referred to in our previous note on this subject, we met with the very early form of Microscope shown in our fig. 12. The body-tube is of cardboard covered with marbled paper, and slides in the split ring-socket on the top of the tripod for focusing. A draw-tube of cardboard carries an eye-piece with a field-lens—the lenses mounted in wood cells. The instrument is in the "Museo di Fisica," Florence, where apparently nothing definite is known of its origin. We are, however, able to assign the construction with considerable probability to Campani from the fact that at the "Conservatoire des Arts et Métiers," Paris, there is a practically identical Microscope bearing the inscription, "Giuseppe Campani in Roma 1673." It is thus evident that Campani constructed eye-pieces with, and also without field-lenses.

L., A. S.—**Differential Screw Slow Motion**—To Mr. Crisp.
[Claim to have anticipated by sixteen or seventeen years Campbell's differential screw fine-adjustment. Cf. this Journal, 1887, p. 324.]
Engl. Mech., XLVI. (1887) p. 416.

Rousselet, C.—**On a small Portable Binocular Microscope and a Live-box.**
[Microscope not figured. Live-box, *infra*, p. 112.]
Journ. Quek. Micr. Club, III. (1887) pp. 175–7 (1 fig.).

(2) Eye-pieces and Objectives.

NELSON, E. M.—**On a new Eye-piece.**
[Cf. this Journal, 1887, p. 928.]
Journ. Quek. Micr. Club, III. (1887) pp. 173–4 (1 fig.).

PELLETAN, J.—**Les Objectifs.** (Objectives.) *Contd.*
Journ. de Microgr., XI. (1887) pp. 546–9.

(3) Illuminating and other Apparatus.

Zeiss' Iris Diaphragm.—Dr. C. Zeiss has designed an Iris diaphragm in which the aperture is approximately circular for all diameters.

Fig. 13 shows the apparatus in its natural size with the six crescent-shaped metal plates, which form the aperture. These slide over one another by the handle on the right. The internal mechanism is shown in fig. 14; one end of the plates is pivoted on the upper plate of the diaphragm case, and at the free end is a straight prolongation which is

FIG. 13.

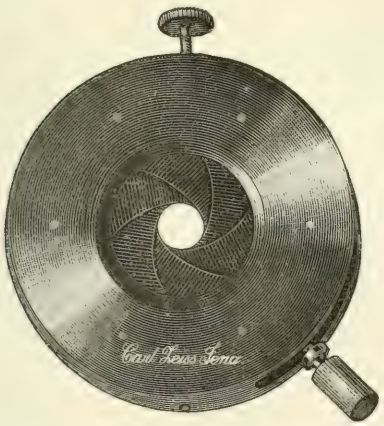


FIG. 14.

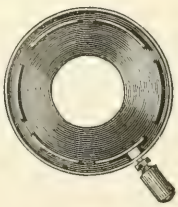


FIG. 15.

inserted between the raised pieces placed round the circumference of the second disc shown in fig. 15; when this disc is rotated by its handle the six plates turn on their pivots. With a turn of the handle to the left the aperture is reduced, and enlarged with one to the right.

By means of the screw (fig. 13) the diaphragm may be fixed to the Abbe condenser and substituted for the ordinary diaphragms. It can be worked with the little finger of the left hand, so that the other fingers can move the slide while the right hand is available for focusing.

We gather that Dr. A. Zimmermann, who describes the apparatus,* is not very familiar with the English and American forms of Beck, Wale, and others. He points out that Iris diaphragms are of advantage in drawing with the camera lucida.

Edmonds's Automatic Mica Stage. — The purpose of Mr. J. Edmonds's apparatus is to rotate a mounted film of mica between the prisms of the polariscope and beneath the object exhibited in the Microscope, producing by the rotation of the mica alone all the colour effects usually obtained by revolving the polariscope by hand. As pointed out by

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 313–5 (3 figs.).

Dr. Carpenter, "The variety of tints given by a selenite film under polarized light is so greatly increased by the interposition of a rotating film of mica, that two selenites—red and blue—with a mica film, are found to give the entire series of colours obtainable from any number of selenite films, either separately or in combination with each other." *

The apparatus is contained in a flat box or case forming a loose stage intended to be laid upon the permanent stage of the Microscope, and the object under examination being placed upon it may be observed and adjusted, or changed from time to time, without disturbing the Microscope or its accessories. The automatic rotation is effected by a specially constructed train of wheelwork which, on being wound up, continues in action for an hour, and when set in motion requires no further attention, enabling the observer to watch the varying effects without touching the instrument. It can be used with any Microscope having polariscopic attachments, is self-contained, and removable at pleasure, and does not interfere with the substage appliances.

Fig. 16.

The designer claims that "the beautiful and interesting phenomena observable in polarizing objects under various aspects, may, with the aid of this self-acting arrangement, be exhibited to a number of persons in succession, with an ease and a readiness not attainable by any other means."

Rousselet's Life-box.†—Mr. C. Rousselet describes a life-box which for pond-life he considers works better than any other contrivance of the kind he has seen. The old life-box, which has done duty for so long, has, in his opinion, the very great defect that the object placed thereon is totally out of reach of the substage condenser, and, therefore, incapable of being properly illuminated.

Some years ago Mr. Swift made an improvement by fixing the glass plate, on which the object is placed, nearly flush with the plate of the life-box, as is shown in fig. 17. But this, however, introduced another defect, "that any objects placed in the box could be examined, over the

Fig. 17.

whole field, only with low powers, whilst with high powers only those objects placed near the centre could be reached. Now, it is very frequently desirable to examine an object with a high power after it has been found with a low one, and we all know how very fond living

* Carpenter on the Microscope, 6th ed., 1881, pp. 132–3.
† Journ. Quek. Micr. Club, iii. (1887) pp. 176–7 (1 fig.).

creatures are of getting to the edge of the drop of water in which they are placed, and to shift them to the centre is frequently a very tedious work, and is often fatal to the animal."

To remedy this defect, Mr. Rousselet "had a life-box constructed in which the glass tablet is somewhat reduced in diameter, but the outer ring is enlarged sufficiently to allow any high power to focus to the very edge of the glass tablet, and the result is very satisfactory. An object lying anywhere in the life-box can be reached by the condenser from below, and by both low and high powers from above; besides which, it acts as a very good compressor, capable of fixing, without hurting, the smallest rotifers, and, when you know how to do it, it is also possible to get a rotifer in so small a drop of water that it is unable to swim out of the field of view of a 1/4 in. objective." He has had it in constant use for animals of all sizes, from the smallest infusoria to tadpoles.

Mr. Rousselet has also had a small screw compresser, made on the same principle; "it is very simple and effective, and allows of regulating the pressure to a nicety."

Large form of Abbe Camera Lucida.*—Dr. Zeiss makes a form of this camera lucida with a larger mirror and a longer arm than the one first issued.† The larger form (only made to order) is recommended by Dr. P. Mayer. The advantage of it he considers to be that it enables the whole field of vision to be utilized without any perceptible distortion of the image, and it is thus especially useful in drawing comparatively large objects with low powers. With the smaller camera the whole field can be projected on the drawing-paper only by giving the mirror an inclination differing so much from the angle (45°) required for accurate drawing that the image is more or less disproportioned. Dr. Mayer further says that "the Abbe camera is superior to that of Oberhäuser in two important particulars: it gives a much larger field of vision and better light. Its construction does not admit of use with the Microscope-tube in a horizontal position. This is a defect which ought to be at once corrected. The Abbe cameras, especially the larger one, can be used to great advantage with the embryograph of His. It is only necessary to add to the stand a horizontal arm, to which the camera can be fastened."

May's Apparatus for Marking Objects.‡—Mr. R. Hitchcock, in reference to Schiefferdecker's apparatus,§ calls to mind a "much simpler, but no doubt quite as efficient device for the same purpose," that he has used for years, made by Mr. May, of Philadelphia. It consists of a simple rod of brass about 1/4 in. in diameter, with a screw at the top that fits into the nose-piece in place of an objective. A tube fits loosely over this rod, bearing a diamond point below, slightly eccentric. This is turned by a milled collar, so as to scratch minute circles on the cover-glass.

Simple Method of Warming and Cooling under the Microscope.‖—Herr H. Dewitz describes a very simple apparatus for warming and cooling objects under the Microscope. It only cost 2*s*., and for many purposes proved entirely satisfactory.

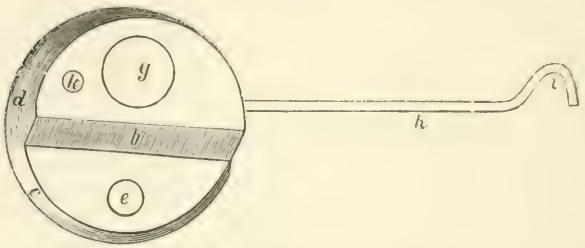
Take a round leaden box, 0·08 m. in diameter, 0·03 m. in height at

* Amer. Natural., xxi. (1887) pp. 1040-3 (1 fig.).
† Cf. this Journal, 1883, p. 278.
‡ Amer. Mon. Micr. Journ., viii. (1887) p. 207. § See this Journal, 1887, p. 468.
‖ Arch. f. Mikr. Anat., xxx. (1887) pp. 666-8 (1 fig.).

the middle; suppose the lid cut away so as to leave an opening 0·08 *m.* in length and 0·023 m. in height. This opening is closed by soldering a piece of lead *b* in such a way that the box is divided into two communicating portions, one *c* lower than the other *d* (fig. 18).

On the floor and roof of the flatter half two opposite circular openings *e* are made. These are covered with a cemented glass. The whole is

Fig. 18.



arranged on a metallic circle beneath so that the lower glass is not rubbed or injured by moving the apparatus on the stage.

On the roof of the deeper half a large hole is made for pouring in water and inserting ice fragments. A smaller hole receives a thermometer. Finally, just above the floor of the higher portion, the end of a tube *h* is inserted. The free end *i* of this tube, which is about the size of a goose-quill, is curved so that water cannot flow out.

Before use, the apparatus is half-filled with water poured in by the large hole, air-bubbles under the glass are got rid of, and a drop of fluid medium containing the object to be observed is placed on the upper glass, and carefully covered in familiar fashion.

The projecting tube is then warmed by a spirit-flame till the thermometer in *k* indicates the desired temperature. A glass should be placed below the free end to receive expelled drops.

For cooling purposes the apparatus is filled a third full with water at the temperature of the room or higher, and ice particles are inserted at the opening *g*. An overflow can be emptied out, viâ the long tube, by inclining the Microscope and without disturbing the arrangements. The layer of water between the two glass plates is quite thin, so that the strength of the light is but slightly altered.

Apparatus for determining Sensibility to Heat.*—An apparatus for the investigation of the heat sensibilities of the cockroach is described by Prof. V. Graber. A trough of tin is divided into two end chambers and a middle chamber whose floor is of wood, and which can be separated from the end chambers by sliding doors. All three are covered by sliding lids of glass or of tin at pleasure, and the whole is surrounded by water-baths, two lamps placed underneath these enabling the end chambers to be kept at temperatures differing by any wished amount. The lamps are prevented from interfering with each other's action by a wooden block under the middle chamber, which serves also as a stand

* Arch. f. d. Gesammt. Physiol. (Pflüger), xli. (1887) pp. 241–3.

for the whole apparatus. In each chamber one thermometer takes the temperature of the air, while the bulb of another is imbedded in felting so as to give the temperature of the walls.

(4) Photomicrography.

Israel and Stenglein's Photomicrographic Microscope.*— Dr. O. Israel's photomicrographic apparatus (fig. 19) may be used either in a

Fig. 19.

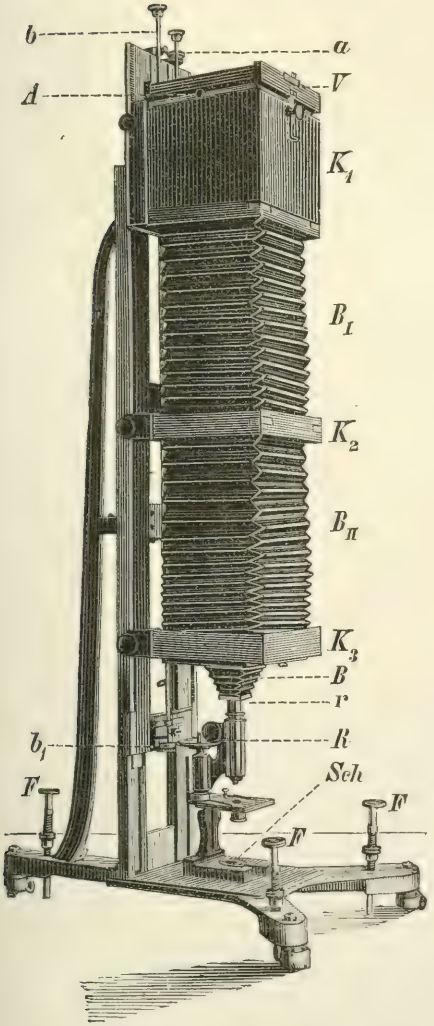
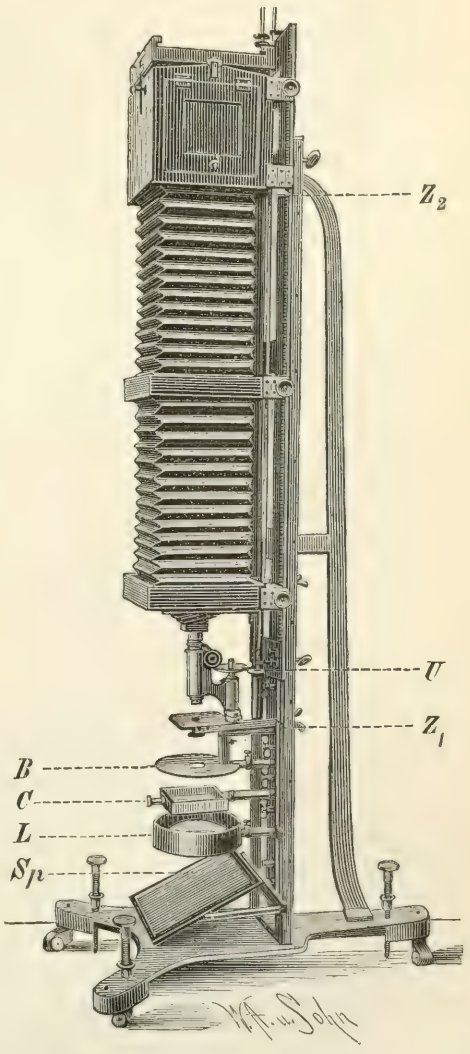


Fig. 20.



* Stenglein, M., and Schultz-Hencke, 'Anleitung zur Ausführung mikrophotographischer Arbeiten,' 8vo, Berlin, 1887, pp. 4–12 (2 figs.), 14-6 (1 fig.).

horizontal or a vertical position; in the former, the iron frame to which it is attached is fixed upon a table, using an inclining Microscope; in the latter the instrument is supported as shown in the figure upon an iron stand, which runs upon wheels, but can be fixed in any position by means of the three screws F. The apparatus consists of two parts, the Microscope and the camera; V is the focusing screen, upon which the image is focused by means of the rod $b\,b_1$, terminating in a toothed wheel b_1, which works into a similar but larger toothed wheel R, occupying the place of the usual micrometer-screw. B is the light-proof connection between the camera and Microscope, and consists of a leather bag fixed to the Microscope by the ring *r*. The camera consists of the three mahogany frames $K_1\,K_2\,K_3$, united by the leather bellows $B_1\,B_2$, which can be extended to the length of a metre; the focusing screen can be rotated about an axis A, perpendicular to the axis of the instrument. *a* is a screw spindle, placed close to *b*, by means of which the camera may be clamped in any desired position to its iron standard. When the apparatus is used in the vertical position the Microscope simply stands upon its iron base, and is fixed below the camera by means of a screw-clamp *Sch*, which grips its horseshoe stand. The size of the plates used with this apparatus is 15 × 15 cm.

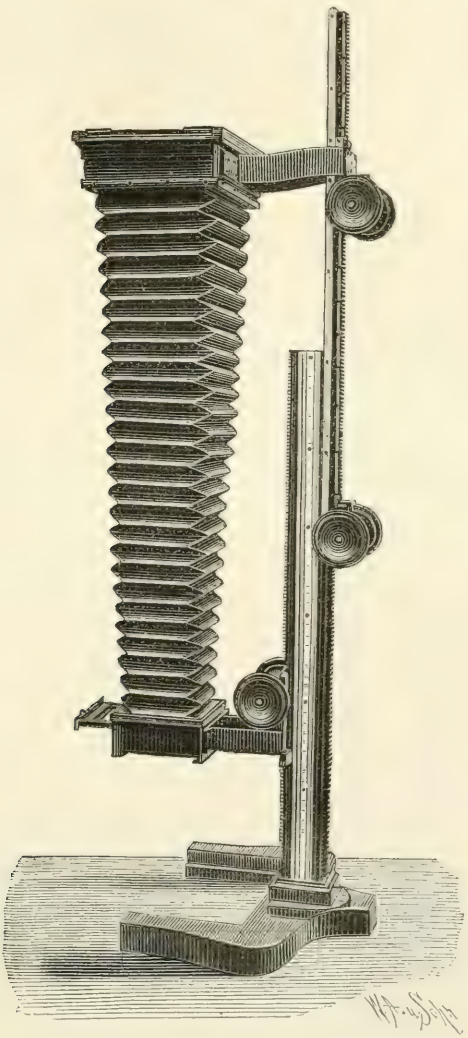
Fig. 20 represents the similar instrument of Herr M. Stenglein, which carries its own illuminating apparatus. For this purpose the height of the instrument is considerably increased; a space of 66 cm. at the lower end of the standard serves to carry the movable parts which constitute the illuminating apparatus, namely a plane mirror 20 cm. square *Sp*, a condenser of 10 cm. radius and 21 cm. focal length L, a light-filter C, to secure monochromatic light, consisting of a vessel filled with ammoniacal solution of copper oxide, and Abbe's illuminator; to these may also be added, if necessary, a diaphragm B, which is to be employed when electric light is used, and in this case the mirror is replaced by the electric lamp. To preserve the centering, the illuminator and the Microscope not only slide along the upright, but are provided with a slight lateral adjustment, and the apparatus is centered by using the smallest diaphragm of the Abbe illuminator and a diaphragm of equal size, which is made to be attached to the condenser.

Stegemann's Photomicrographic Camera. — The instrument represented in fig. 21, and devised by Herr A. Stegemann, corrects, it is claimed, a defect of the ordinary apparatus by supplying the means of adjusting the distance between the objective and the focusing screen, upon which depends the relative size of the photographic image, and by measuring this distance upon a fixed scale. A square pillar rising from an iron foot carries the camera, with the objective-frame and the focusing screen which slide upon it; the pillar is graduated, and by means of a vernier attached to the adjustment-screw of the camera gives the exact distance between objective and focusing screen. The apparatus can be used either to photograph objects in their natural size, in which case the object is placed on a glass plate fixed to the foot; or with the Microscope, which is then placed in the forked support which serves to carry the glass plate.

In this instrument the stratum of liquid which is used as a light-filter for monochromatic light is contained in a vessel which slides into

the case of the objective-frame close to the objective, so that all rays which reach the sensitive plate must of necessity have passed through the solution.

Fig. 21.



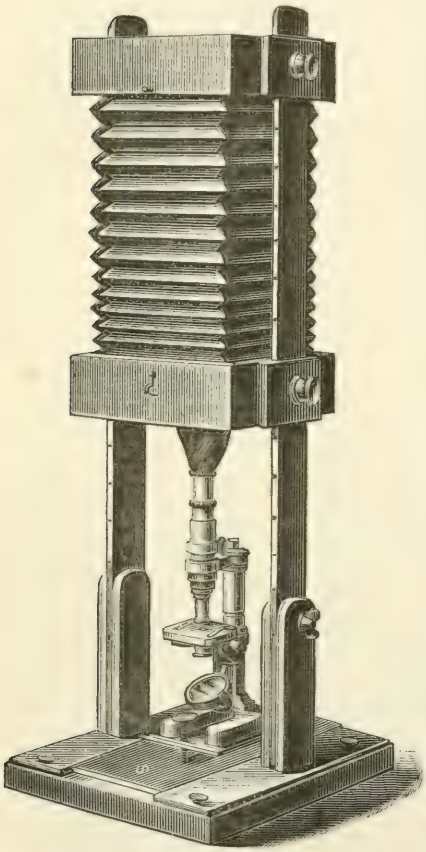
Marktanner's Photomicrographic Cameras.*—Herr T. Marktanner describes two photomicrographic cameras which he has devised.

The first is made on the Gerlach system, and consists of a wooden chamber, not made to draw out, which is placed upon the body-tube. It is distinguished from the camera of Gerlach by the basal table, which is

* Bull. Soc. Belg. Micr., xiii. (1887) pp. 188-91 (2 figs.).

made of two equal-sized plates united by a hinge. The upper plate forms the base of the camera, which is pyramidal in shape; the lower is provided with a brass tube, accurately centered, by which the camera is adapted to the tube. If the preliminary adjustment is made by means of rackwork, the brass tube may be an elastic cap which is fixed to the upper part of the Microscope by a screw clamp. To secure greater stability, it is better to apply this camera to a stand, with which the preliminary focusing is made by a sliding movement. In this case the use is recommended of a strong brass tube of the same size as the body-tube, ending in a screw-thread similar to that of the objectives. If it is desired to use objectives of different screw-threads, it will be better to employ several brass tubes of 8 cm. length, which can slide into the tube fixed at the centre of the lower plate. This camera will be especially useful in obtaining plates which give the full views so useful as aids towards drawing. As the amplification will never be more than 200 times, cardboard holders will be quite sufficient. The size of the plates is 6 cm. by 6·5 cm., and they are made by cutting a plate of 13 cm. by 18 cm. into six parts. The slide for the transparent glass is made of cardboard; the glass is covered with a fine network of lines. The hinge which unites the two basal plates enables the camera to be lowered beside the Microscope. This arrangement is very useful when the apochromatic objectives of Zeiss are used, and also with the projection eye-pieces constructed for photomicrography. The eye-pieces can then be easily changed. This arrangement was formerly less necessary than now, for with the objectives then used, photographs were almost always taken without the eye-piece.

Fig. 22.

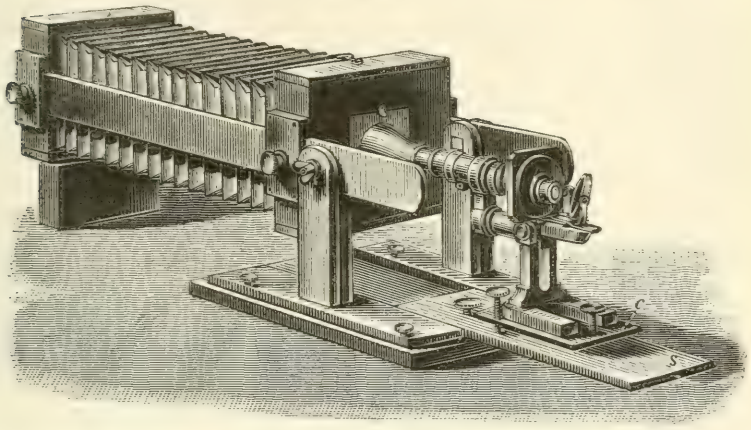


The second camera (fig. 22) is sufficient for all the purposes of photomicrography. It is similar to that of Nachet, from which it is only distinguished by the bellows, by a slide in the basal plate, and by a levelling apparatus formed of a plate of zinc upon three screws.

This camera can be used in the horizontal (fig. 23) as well as in the vertical position. In the former it draws out to 90 cm.; in the latter to 50 cm. The transparent glass is made as in the preceding camera.

If the projected image is exactly focused, it ought to be seen with the lens at the same time with the fine lines traced upon the glass. In this

Fig. 23.



apparatus the size of the plates is 12 cm. by 16 cm., a size which is recognized as sufficient by all who have had experience in photo-micrography.

Nelson's Photomicrographic Focusing Screen.*—Mr. G. Smith, in reference to Mr. Nelson's suggestion† for ruling the focusing screen with metrical and English scales, considers that if diamond lines are used they should be ruled horizontally and vertically about $\frac{1}{20}$ in. apart; but better still, every third line should be missed. The cross ruling thus forms a kind of plaid pattern, and any decided pattern materially assists the eye in keeping to the proper plane instead of seeking a focus on either side. The eye-piece must of course be first adjusted exactly to these lines for the operator's eye.

Another very simple and effective plan (applicable to other cameras too) is to rule diagonals in blacklead pencil across the ground glass, and over the centre cement a thin cover-glass, taking care to put there a few grains of dust, or say, cotton fibre. Both these plans he has used for many years, and can recommend both; with either it is easy to focus the darkest interior.

Neuhauss, R.—**Anleitung zur Mikrophotographie für Aerzte, Botaniker, &c.** (Guide to Photomicrography for Physicians, Botanists, &c.)
32 pp., 8vo, Berlin, 1887.

Sternberg, G. M.—**Photo-micrography in Medecine.**
Reference Handbook of the Medical Sciences (*U.S.A.*) 1887, pp. 647–58 (7 figs.).

(5) **Microscopical Optics and Manipulation.**

Histological Structures and the Diffraction Theory.—Hitherto the examples of the action of diffraction in microscopical vision have been almost entirely confined to diatoms, objects which more than any others are suited to illustrate the principles on which the theory is founded,

* Eng. Mech., xlvi. (1887) p. 394. † See this Journal, 1887, p. 1028.

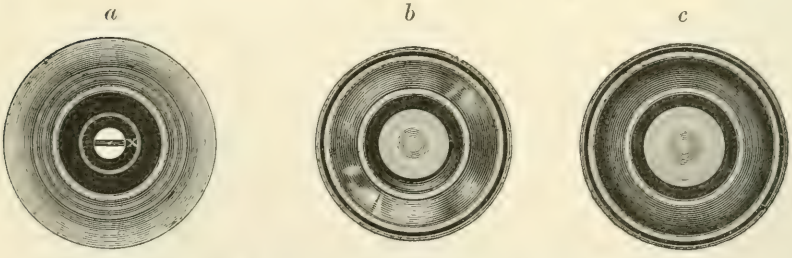
viz. that in the case of minute objects which are less than a few wave-lengths in diameter the laws of geometrical optics no longer apply, that is, the structures are no longer imaged according to the laws which govern the delineation of objects observed with the naked eye, but that the delineation is dependent upon the rays which are diffracted by the object. The matter is, however, obviously of more importance to histologists than to the observers of diatoms. In the case of histological structures the conditions are, of course, much more complicated than with diatoms, but the principles remain the same, and if they are not taken into account very false deductions may be made. A notable instance of this was the case on which we commented in 1881,* where Mr. J. B. Haycroft † put forward an explanation of the appearances presented by muscle-fibre which, while an eminently simple one, was unfortunately entirely founded on the supposition that the fibres acted in the same manner as cylindrical threads of larger size.

Prof. S. Exner, who has recently investigated the question of muscle-fibre, has published an article on the subject, in the course of which he deals fully with the operation of diffraction on such structures. This article from the point of view we are now considering is a very interesting one, and we have translated his remarks without abridgment.

In order that the subject may be fully understood, we have prefaced the translation by notes on (1) the appearances presented by air-bubbles and oil-globules, by solid and hollow fibres, and by depressions and elevations where the objects are larger than a few multiples of a wave-length, and (2) the appearances presented by *Pleurosigma angulatum* under different optical conditions.

(1) *Appearances presented by Air-bubbles and Oil-globules, by solid and hollow Fibres, and by Depressions and Elevations of relatively large size.*‡—The accompanying figs. 24 and 25 supplement those given at

Fig. 24.



Air-bubbles under the Microscope. Focus, *a* below the centre (at the focal plane), *b* to the centre, *c* the same with oblique light stopped off.

p. 743 of Vol. II. (1882), *a* in fig. 24 representing an air-bubble when the Microscope is focused below its centre (*x* being the image of a window bar), *b* when focused to the centre, and *c* the same with oblique

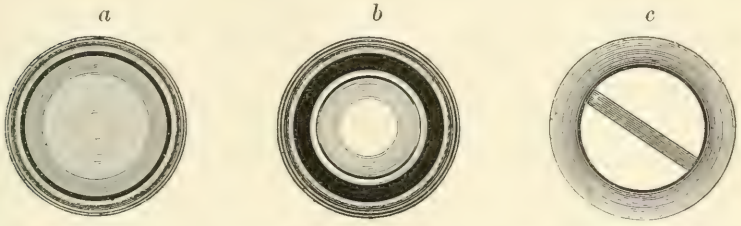
* See this Journal, 1881, p. 964.

† Proc. Roy. Soc. Lond., xxxi. (1881) pp. 360–79 (1 pl.).

‡ Cf. Dippel, L., 'Das Mikroskop und seine Anwendung,' 1867, pp. 313–4 (4 figs.), pp. 355–60 (9 figs.), and 2nd ed. 1882, pp. 822–4 (4 figs.), pp. 852–6 (6 figs.).

light stopped off. Fig. 25 represents an oil-globule, *a* with the focus on the margin, *b* somewhat higher, and *c* at the focal plane of the bubble.

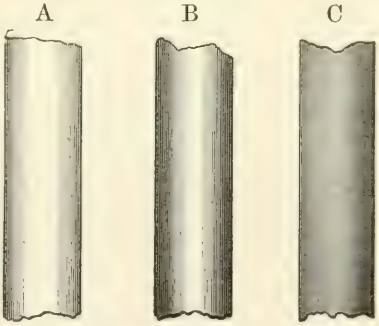
FIG. 25.



Oil-globules under the Microscope. Focus, *a* on the margin, *b* somewhat higher, *c* higher (at the focal plane).

Solid fibres, fig. 26, in a medium of lower refractive index (as a glass thread in air or water) show a diffused moderately bright appearance A at medium focus; a bright central line B when the tube is raised; and a dull appearance C when the tube is focused below the centre. The reverse of course takes place if the surrounding medium is of higher refractive index, as glass threads in monobromide of naphthalin or biniodide of mercury and potassium. If, again, the fibre is surrounded by a fluid of about the same refractive power, as in the case of a glass thread in Canada balsam, it will then have the appearance of a flat band.

FIG. 26.



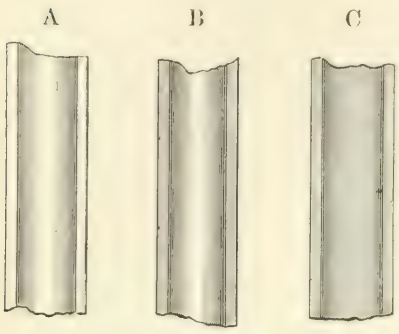
Glass threads. Focus, A medium, B higher, C lower.

Hollow fibres charged with air, fig. 27 (or a fine capillary tube of glass), present with medium focus nearly the same appearance as the solid fibres, from which they are only to be distinguished by the fact that at both edges the double outline of the section of their solid walls will be seen as in A. In other respects the appearances are reversed; the raising of the objective giving a dull image C, whilst on sinking it we have the central bright line B. Fine tubes in a denser substance produce the same effect as hollow fibres. Semi-cylindrical channels or furrows act as concave lenses, whether the hollow side is turned from or to the observer. The only distinction between the two positions is, that in the former case the tube must be focused lower than in the latter, in order to obtain the greatest degree of brilliancy in the central line.

If instead of the hollow fibre, or capillary tube charged with air, one filled with a fluid is substituted, this produces the same effect as a solid fibre, provided the contained and the surrounding fluid are nearly the same, or if the former has a greater refractive power. Solid and hollow fibres can then only be distinguished from each other in the medium focus, showing the optical section of the solid walls. On filling with a

fluid similar to that surrounding the fibre, an effect is produced more or less similar to that of the air-charged fibre, for if the refractive power of the contained and the surrounding fluid is greater than that of the solid walls, the latter will appear as hollow spaces in the stronger refracting medium, as would be the case with glass capillary tubes filled and surrounded with monobromide of naphthalin.

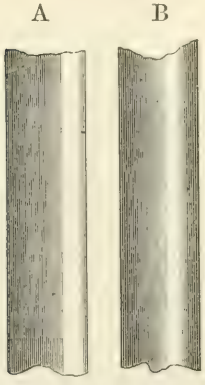
Fig. 27.



Glass capillary tubes. Focus, A medium, B lower, C higher.

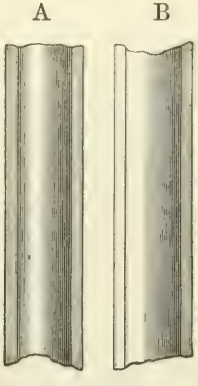
If oblique illumination is employed instead of central, the appearances just described are not essentially altered; a displacement of the illuminated line to the one side or the other is simply produced, according as the mirror is moved out of the axis to the right or left. With objects which act as convex lenses it is generally displaced to the side of the object which is turned away from the source of light, and with objects acting as concave lenses to the side nearest to the light; and therefore, as the compound Microscope inverts, it will appear in the first case on that side of the image which is turned towards the mirror, and in the latter case away from it. The glass thread or the solid fibre will therefore show the line of light on the side turned towards the mirror, when the illumination falls obliquely and the tube is raised; hollow cylinders and furrows will show it, when the tube is lowered, on the side of the image which is turned away from the mirror. The division of light and

Fig. 28.



Glass threads with oblique light incident from the right. Focus, A high, B somewhat lower.

Fig. 29.



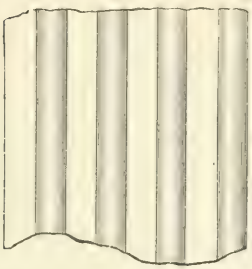
Glass capillary tubes with oblique light incident from the right. Focus, A low, B a little lower.

shadow will appear as in A, figs. 28 and 29. If a more medium focus is taken, the conditions are so far altered, that now half of the object is

in shadow, while the other half is illuminated as strongly or even stronger than the field B, figs. 28 and 29.

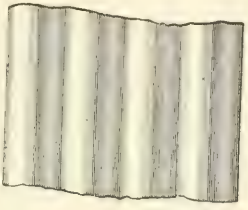
If depressions either with spherical surfaces or furrowed or bowl-shaped (fig. 30) are found on the surface of a membrane, they produce the same effect as concave lenses, and show their greatest brightness when the tube is lowered. If, however, there are spherical, hemi-spherical, or semi-cylindrical elevations, they act as convex lenses and

Fig. 30.



Semi-cylindrical elevations or depressions.

Fig. 31.



Cylindrical elevations and depressions.

show their greatest brilliancy when the tube is raised from a medium focus. If furrow-like depressions alternate with semi-cylindrical elevations, the surface presenting a wavy appearance, the former appear bright when the tube is lowered, the latter when it is raised, and when the former show the highest degree of brilliancy the latter has a dull appearance (fig. 31).

With wave-like membranes the result is somewhat different, since here both of the undulations, as well those which have their convex side towards the observer, as those with the concave side so turned, act as concave lenses. They therefore show their greatest brightness on lowering the objective, and the same differences in the extent of the lowering as in the case before mentioned of the semi-cylindrical tubes.

From what has been said of glass threads and hollow cylinders filled with fluid, it follows that more and less strongly refracting (i. e. dense and less dense) parts of one and the same object, will act similarly to the cylindrical elevations or depressions of a membrane. In observing, therefore, in water the differences thus presented in the microscopical image, it is necessary, in order to decide whether these depressions or elevations are caused by variations in *structure* or in *density*, to change the fluids, and particularly to use such substances as possess a greater refractive power than the object under examination, whereby the image is either (in the first case) changed according to the altered conditions, or (in the latter case) is substantially unchanged. If the greatest brilliancy appears when the tube is lowered, we have to do with an elevation, but if when the tube is raised, it must be a depression. In order to facilitate the determination of the position of the tube, we can either start with a medium focus, or the tube may be lowered from a point at which no distinct image of the object is obtained. Depressions are then first bright on a dark ground, elevations, on the contrary, dark on a bright ground, till after further lowering of the tube the image is exactly

reversed. For accuracy in the determination, the object must be in its natural condition, and must not have been disturbed by any changes in density, or by any previous preparation, drying, &c.

(2) *Appearances presented by Pleurosigma angulatum under different optical conditions.*—Hugo v. Mohl and Schacht regarded the markings as formed by three intersecting sets of lines; to Max Schultze and others they seemed to be six-sided depressions; to some English microscopists they appeared to be six-sided elevations, while Schiff and Dippel recognized a chess-board pattern. Stein, Pelletan, and Kaiser have recently referred to round protuberances, while Dr. Flögel has proved, by means of transverse sections, that at any rate the upper surface of the valve (with the exception of the central rib and the edge) is to be regarded as flat, but that it is full of cavities between its upper and under surfaces.

If we look more closely into *Pleurosigma angulatum* by the light of the diffraction theory, we obtain the following result:—Using purely central illumination, i. e. a very narrow illuminating pencil, if the numerical aperture of the objective is sufficiently large, and is at least 0·90 to 0·95, we have six spectra a_1–a_6 (circle A, plate III. fig. 1), which are arranged regularly round the direct image of the source of light, while the six spectra of the second series a_1–a_6 fall outside the aperture even with very large numerical aperture. If the aperture is so small that with purely central illumination no one of the six least deflected pencils is admitted, the valve appears to be without markings, while with a larger aperture of above 1·00 N.A. the three systems of striæ I.–III. (plate III. fig. 2) make their appearance at the same time, and according to the excess of the aperture above unity give rise to a fainter or more sharply defined pattern. Each one of these systems of striæ can also be made visible with a numerical aperture of 0·50 when oblique light is used; in that case two spectra a and a_1 or a and a_2 (circle B, plate III. fig. 1) always fall within the aperture. They may also be obtained in the same way with objectives of greater numerical aperture when all the other spectra, with the exception of one of those mentioned, are excluded by suitable diaphragms. With an objective of 0·7 to 0·8 N.A. as soon as the light is oblique enough, three pencils are included, the direct and two diffracted pencils (circle C, plate III. fig. 1), and then the two sets of striæ I. and II. intersecting at 60° are obtained.

If the direct pencil is excluded and only two opposite spectra a_1 a_4–a_2 a_5, a_3, a_6, allowed to operate, there appear in succession three new sets of striæ IV.–VI. which owing to the exclusion of a are bright upon a dark field; and the striæ are brought nearer to one another in the ratio of 2:1, so that they appear twice as fine as I.–III. though they coincide with the latter in direction.

The systems of striæ vii.–ix. which are at right angles to the ordinary sets I.–III., and of which the lines are closer together in the proportion $\sqrt{3}$: 1, are obtained in a bright field when with objectives of very large aperture, the spectra of the first series a_1–a_6 are intercepted by suitable diaphragms, and the objective receives the direct pencil a together with one of the spectra of the second series such as $a\,a_1$, $a\,a_2$ . . . $a\,a_6$. The striation IX. can be obtained by $a\,a_2$ and $a\,a_5$ when oblique light is allowed to fall upon the central rib.

The same sets of striæ can be produced upon a dark field when, using central light and an objective of large numerical aperture, a and

Fig. 1.

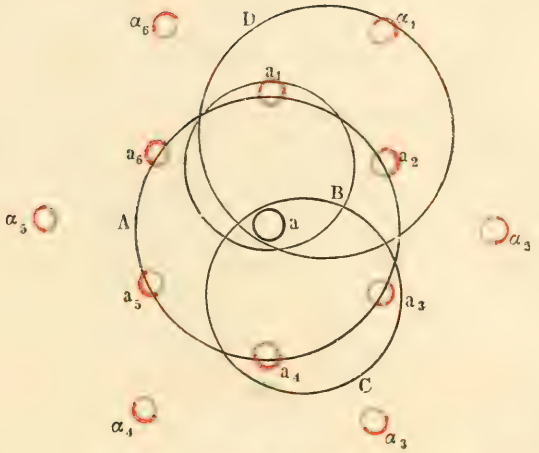


Fig. 2.

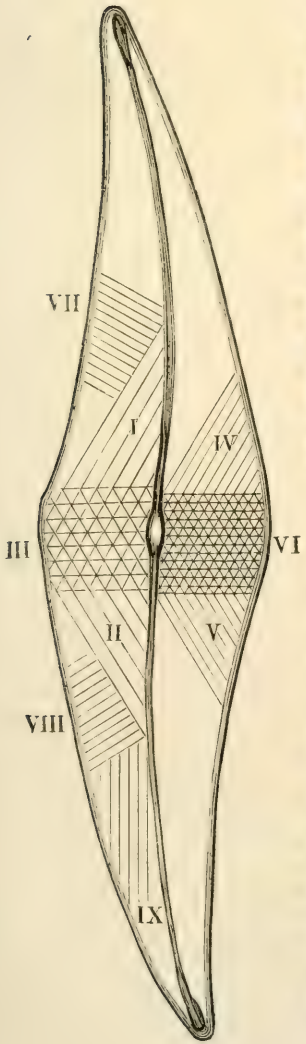


Fig. 3.

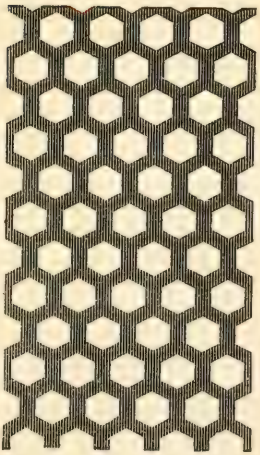


Fig. 4.

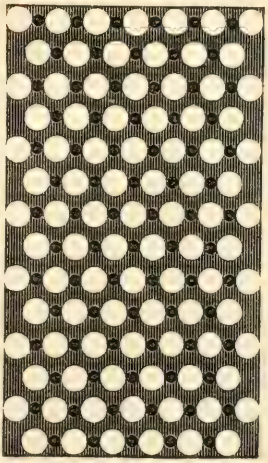


Fig. 5.

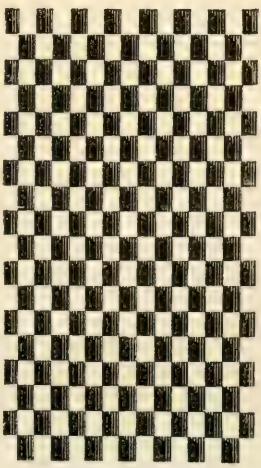
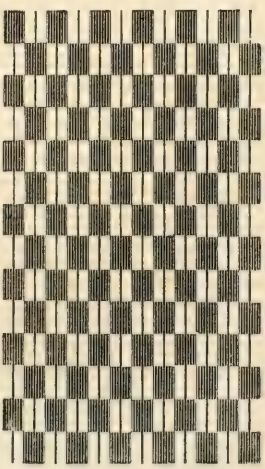


Fig. 6.



Pleurosigma angulatum.

all the other spectra are shut off with the exception of two belonging to the series $a_1\ a_3$, $a_2\ a_4 \ldots a_4\ a_6$. The striation IX. is then repeated twice by $a_2\ a_6$ and $a_3\ a_5$.

Since the distance of the spectra $a\ a_1$, $a\ a_2 \ldots$ or $a_1\ a_3$, $a_2\ a_4 \ldots$ is greater in the ratio $1 : \sqrt{3}$ than that of $a\ a_1$, $a\ a_2 \ldots$ the lines of the striæ VII.–IX. must be closer to one another than those of I.–III. in the ratio $\sqrt{3} : 1$. The new striations IV.–IX. called into existence by the above arrangements possess the same sharpness of outline as those which have been long known, namely I.–III.

The above appearances serve to explain the different views which have been held with regard to the structure of diatoms, when they are observed with different modes of illumination. Dry and water-immersion objectives of no great numerical aperture show the well-known hexagons (plate III. fig. 3) when the illumination is central and with a not very minute diaphragm, or when the illumination is oblique if e. g. $a\ a_1\ a_2\ a_3$ or $a\ a_1\ a_5\ a_6$ are operative. Large numerical aperture with central illumination gives bright circles arranged in lines which intersect at 60°, and between which with very sharply defining objectives (homogeneous-immersion for instance) dark spots are also visible (plate III. fig. 4). Oblique illumination and the action of $a_1\ a_2\ a_3$, $a_1\ a_5\ a_6$, with a numerical aperture up to 1·10 shows a chess-board pattern as described by Schiff and Dippel (plate III. fig. 5). Very oblique illumination and the action of $a\ a_2\ a_3\ a_2$ or $a\ a_5\ a_6\ a_5$ with objectives of very large numerical aperture give the peculiar figure first observed by Stephenson and Abbe, in which the bright rectangular spaces are traversed by a small dark line and are accompanied by dark markings equal to the first in size and lying above and below them (plate III. fig. 6). Other forms may be obtained on a bright or dark field by the use of various modes of illumination and of diaphragms which intercept certain spectra of the first and second series and only allow the remainder to operate.

That the ordinary markings which are seen with an objective of large numerical aperture and with central illumination are more nearly related to the true structure than the other images, can only be concluded from conditions of their production, and not from the images themselves. These markings appear when the largest possible part of the total spectrum of the *Pleurosigma* valve is in operation, and as little as possible (i. e. only the furthest fainter pencils of the second and third series) is lost; while each of the other images is produced by a much smaller part of the total diffraction spectrum. For this reason it may be concluded that the former image is less dissimilar than the others from the image which corresponds to the complete diffraction action of the valve, and which is unattainable by any Microscope.*

(3) *Prof. Exner's remarks on the Optical character of living Muscle-fibres.*†—Prof. S. Exner employed his micro-refractometer ‡ to determine the refraction and double refraction of living muscle-fibres, and to answer the question whether transversally-striated fibres have their refractive index increased or diminished during contraction. The paper, as we have above stated, is more particularly interesting to microscopists from the observations which the author makes on the application of the

* Dippel's Das Mikroskop, 1882, pp. 158-61 (6 figs.).
† Arch. f. d. gesammt. Physiol. (Pflüger), xl. (1887) pp. 360-93 (2 pls.).
‡ See this Journal, 1886, p. 328.

diffraction theory of microscopical vision to the examination of such minute objects as muscle-fibre.

In the first place, the examination by the instrument of muscle from the femur of *Hydrophilus piceus* showed, beyond a doubt, that the contracted portions of a fibre have a higher refractive index than the remainder; but, on the other hand, Prof. Exner claims to have proved that this is only the case with abnormal contraction, whereas when the contraction is normal, no change is produced in the refractive power. The immersion fluid used to determine the index was either white of egg concentrated over sulphuric acid in the receiver of an air-pump, and treated with acetic acid, or the liquid obtained by pressure from the eye of an ox or sheep. The refractive index of the former can be raised to 1·4053, and that of the latter to 1·42–1·43. A number of trials with these fluids led to the result that the stationary living muscle of *Hydrophilus* has an index of refraction which varies slightly on either side of the value 1·363, while the same muscle may have slightly different values in different parts. As regards what may be called the ordinary and extraordinary rays for light traversing the fibres in a direction perpendicular to their length, measurements of the indices in the sartorius muscle of a frog led to the approximate values $n_o = 1 \cdot 368$ for the ordinary ray, and $n^e = 1 \cdot 370$ for the extraordinary ray.

When the screen of the micro-refractometer is placed with its edge at right angles to the length of the fibres, a peculiar striped appearance is produced, which the author explains as due to the obliquity of the layers constituting the fibre, so that a ray of light is deflected or not according as it does or does not pass through layers of varying refractive index. Now when the waves of contraction which traverse the living muscle of an insect isolated in an inactive fluid of equal or greater refractive index are examined with the micro-refractometer, the screen having its edge parallel to the length of the fibres, it is found that the contracted portions become dark on the side of the screen and light on the opposite side, in other words, the index of refraction in these parts is diminished; if the index were increased, the first effect would be an illumination of the fibre as far as the sarcolemma, and this is never observed.

On the other hand, the permanently contracted and transversally striated parts found in fibres which are still living, especially near the torn ends, do exhibit a marked increase of refractive power; these, however, are regarded by the author not as normal contractions but as a change which accompanies the death of such parts of the fibre; they do not recover their previous character, because the muscular substance has been partially destroyed, and this is proved by three facts—(1) the permanently contracted parts are smaller than those of which the contraction is normal. (2) the death of a fibre is accompanied by the emission of a certain amount of liquid, as may be proved by examining the fibre in liquid paraffin (refractive index = 1·4712), when the micro-refractometer indicates that the contracted portion is surrounded by a liquid of less refractive index than the paraffin; (3) it is only necessary to examine a free fibre under the Microscope, when it will be found after a few hours to have contracted and to be surrounded by liquid, and a contracting portion may be occasionally seen during a few minutes to surround itself with a ring of liquid as it contracts.

It may be concluded therefore that there is an absolute distinction to

be made between the normal living contractions and the permanent contractions which are accompanied by a partial destruction of the muscle-fibre, and that the latter only are marked by an increase of refractive power.

So far we have given an abstract only of the author's paper. His "Remarks on our Knowledge of the Structure of the Transversally Striated Muscle-fibres" which follow, we translate *in extenso*.

"It seems to me therefore that the very contradictory data concerning the anatomical relations of a muscle-fibre during contraction require revision. It will be asked why I do not undertake this revision. The answer is, that such a revision is not possible without an accurate knowledge of the relaxed muscle-fibre, and that I feel myself unable to form an opinion as to whether certain results of late investigations on this subject are reliable or not. I regard not only myself but others also provisionally as unable to form this opinion for reasons which will be explained in the following remarks.

Where twenty years ago a distinction was only drawn between singly and doubly refracting substance in the muscle, there is now recognized a sequence of the parallel layers (using Rollett's nomenclature) Z, E, N, J, Q, *h*, J, N, E; nine layers in place of two; these layers are conveniently described as of a thinness which approaches 'the limits of the perceptible.'

If we consider that the whole of geometrical optics, i. e. the recognized laws of the formation of images, only holds good so long as the relation between the magnitude of the object and the wave-length of light does not fall below a certain limit;* and if we consider, further, that the wave-length of light in air (e. g. for the line C†) is 0·000589 mm., and in muscle-fibre (n = 1·363) is 0·000432 mm., and that these numbers are greater than the thickness of the single layers, we must ask ourselves whether these anatomical results have any value at all.

To this it must be added that Abbe, the first living authority on the theory of the Microscope, says with regard to the diffraction-images produced by the transverse striation of the muscle-fibres, 'The manifold changes in the character of the image' (produced by the transverse striation) 'explain to some extent the well-known difference between the observations of various investigators with regard to these appearances, but prove also the impossibility of acquiring any definite knowledge about their actual physical structure' (i. e. of the fibres) 'in the sense of the attempts which have hitherto been made.'‡

Thanks to the investigations of the same physicist, we now know that the formation of a true microscopic image depends upon whether all those rays contribute to the formation of the image on the retina which are diffracted by the boundaries (whether sharply defined or gradual) between parts of the object of different refractive powers, or by inequalities of the object, &c. If this is not the case we may receive illusory images; the finer the structure which we attempt to resolve by the Microscope, the greater is the probability that a portion of the diffracted rays will not reach the eye. Beyond a certain limit of fineness this probability becomes a certainty, and Abbe concludes 'that no Microscope has ever shown, or will ever show, anything actually existing in the

* Cf. Helmholtz, "Ueber die Grenzen der Leistungsfähigkeit des Mikrokopes," SB. Berliner Akad., 1873, p. 625.

† According to Ditscheiner.

‡ Arch. f. Mikr. Anat., ix. (1873) p. 454.

object which cannot be clearly distinguished by a normal eye with a sharp immersion amplification of 800.'

To many microscopists the physical deductions will perhaps be less accessible than the experiments which show that the lines of a microscopic grating are doubled when a portion of the diffracted rays are prevented from reaching the eye; that by screening off another part lines can be seen running in a direction different to those of the lines of the grating, &c.

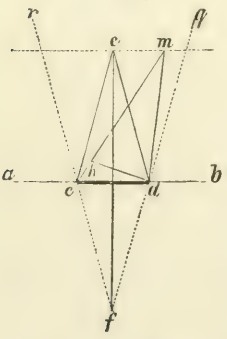
Even the microscopist who has no desire to work at the theory of these phenomena must at least be made anxious by them, and his anxiety is the more justified by the fact that there is no criterion by which we can know whether some of the rays have been lost to the retina or not.

It is this feeling of anxiety with which I am concerned. How many pages have been written upon the structure and the linear markings of *Pleurosigma angulatum!* We now know that various authors have seen the markings differently, and we know why this is so, and that we may perhaps learn the true structure in some other way, but never by simple microscopic observation as has been attempted. Are we not upon similar ground in the case of the muscle-fibres? In any case it seems to me that we must tread it with caution.

Now it is this caution and this feeling of anxiety which I miss in the later investigations on muscle-fibres; although our knowledge of the relation between the diffraction phenomena and the microscopic image is old enough, I do not remember to have ever found in the literature of the subject a clear and definite expression which would indicate any fear of falling into the error which I have pointed out.† Yet facts so glaring as those which I have adduced, and such authors as Helmholtz and Abbe, cannot be overlooked.

There is a special group of diffraction phenomena to which I will draw attention. The rays which traverse the object naturally interfere in the wide space between the retina, the object, and (according to the usual optical mode of expression) beyond the latter.

Fig. 32.



Let $a\,b$ (fig. 32) be a plane wave-surface, $c\,d$ a small opaque particle. In e will meet rays without difference of phase, which have passed c and d and have been diffracted at those points. If then the Microscope is focused upon e a bright spot is seen. As the objective is moved towards $c\,d$, i. e. as it is adjusted for successive points in the line $e\,f$ which lie between e and $c\,d$, the conditions are the same for all these points until the rays $d\,e$ and $c\,e$ have so great an inclination, that with the particular aperture in use they no longer contribute to the formation of the image. If the Microscope-tube is depressed until it is adjusted for a point below $c\,d$, the bright spot returns and is now due to the rays $r\,f$ and $q\,f$ which have no difference of phase. With regard to points lying on either side of the median line $e\,f$ the case is different. If m is a point at which the diffracted rays $c\,m$ and $d\,m$ meet, with a difference of path equal to a half wave-length $c\,h$, they destroy one another; e will

* See *infra* as to the fear of similar dangers entertained by Heppner and Dönitz.

therefore be surrounded by a dark ring; all points which satisfy the same conditions as m and which lie in the plane of the figure belong to a hyperbola whose apex lies in $a\,b$; as the tube is raised the dark ring will therefore increase.

According to the conditions e will be surrounded by a certain number of dark rings corresponding to differences of path, which are an unequal number of half wave-lengths, and between them will lie bright rings. These diffraction phenomena may be well seen with particles of Indian ink in water when a round opening of 1 cm. in a screen before a gas-flame is used as illuminator; the same thing may also be seen with ordinary illumination.

Certain interference-bands lie in the immediate neighbourhood of the object, and are seen when the Microscope is focused close to the object; and when the latter has, as is the case with the muscle-fibres, a considerable thickness, the diffraction images may even lie inside the object, and thereby considerably increase the danger of error. Now, as has been said above, the image is no longer reliable when the object attains a certain minuteness, so that in such cases it may be uncertain whether the Microscope is focused on the object or on the diffraction appearances. As is well known, the different interpretations put by Engelmann and Meyer upon the process of contraction in muscle-fibres depend on the different modes of judging what is meant by the 'true' focal adjustment of the object.*

In working with the Microscope we see every day examples of these diffraction images; a sufficiently minute drop of mastic emulsion has naturally a definite outline and a transparent interior, like a larger drop, but this cannot be *seen;* in general, what is seen is a dark point, or with a different focus a bright point surrounded by a dark circle. Whether the object consists of a transparent liquid or a black pigment we cannot say, since the diffraction phenomena are the same in the two cases. With a sufficiently fine thread a similar figure is produced.

The practised microscopist, although he only sees the diffraction phenomena, and even in consequence of them, will realize the existence

* Cf. Merkel in Arch. f. Mikr. Anat., ix. (1873) p. 299. Merkel here attempts to settle the question by examining the primitive fibrillæ in polarized light, and since the ordinary illumination gives no result he employs direct sunlight. I cannot regard this as satisfactory, for in this case the small angular size of the source of light introduces conditions peculiarly suitable for diffraction phenomena. In fact it is impossible to ignore the fact that if the double-refraction has not been essentially altered in the balsam preparations, and there is no reason to believe this to be the case, Merkel's results cannot be attributed to this cause; a single fibrilla is too thin.

If the fibrilla is only visible in blue light upon a dark field the difference of path of the two rays must amount to $\frac{\lambda}{2}$ of this light. According to Ketteler, for the line G in vacuum

$$\lambda_v = 0{\cdot}000430409 \text{ mm.}$$

So that with the above values of n for the ordinary and extraordinary rays in a living muscle-fibre

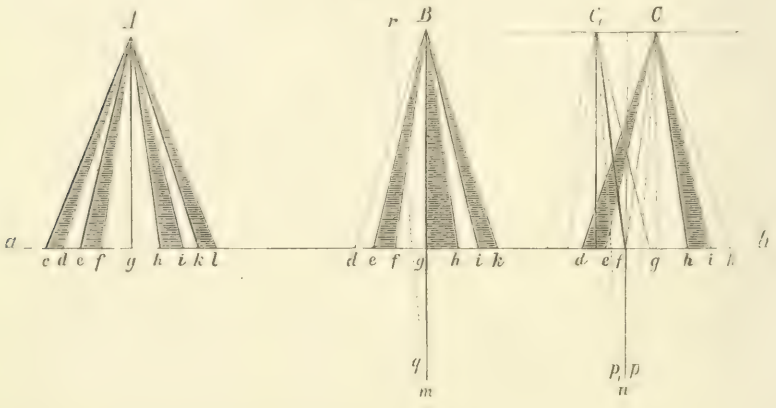
$$\lambda_o = 0{\cdot}00031463 \text{ mm.}$$
$$\lambda_e = 0{\cdot}00031417 \text{ mm.}$$

Assuming for the fibrilla the considerable thickness 0·002 mm. it contains 6·356 waves of the ordinary and 6·366 waves of the extraordinary ray; that is, the difference of path is only 1/100 of a wave-length; and this is not in harmony with the effect described.

of a small particle. But how is he to gain the practice to explain diffraction phenomena in objects of complicated structure, and which he cannot, like a drop of mastic, reproduce artificially? It is scarcely possible either as the result of practice, or on the basis of theoretical treatment, to arrive at a clear explanation of all the images produced by different focusing, thickness of fibre, illumination, &c. The conditions are too complicated, but I will endeavour to make the essential points more clear.

Let $a\,b$ (fig. 33) be the boundary of a muscle-fibre, and $m\,g\,f\,n$ the visible portion of a disc of the same which has a different refractive index from that of the next disc. If A is a point outside the fibre, the intensity of vibration at A of a plane wave of light which traverses $a\,b$ is, according to Huyghens's principle of the elementary zones of spherical

Fig. 33.



waves, the result of the interference of $g\,h$ with $q\,f$, of $f\,g$ with $e\,f$, of $e\,f$ with $d\,e$, of $d\,e$ with $c\,d$, and of similar portions on the other side which reach A. If the path from $g\,h$ to A is a half wave-length smaller than that from $h\,i$ to A, and similarly in the remaining parts, the result of the interference is the extinction of the portion of the wave which is the more remote from A g, and the rectilinear propagation of the ray g A. The shaded portions may represent those parts where wave-troughs reach A at the same moment at which wave-crests arrive from the unshaded parts. If the pencils whose inclination is that of l A, or of the rays beyond l A which are not represented in the figure, do not enter the Microscope, then the above-mentioned case of an incomplete image is realized, which is of course in the present example without signification, since no part of the structure is included.

If the cylindrical form of the fibre is neglected this method of treatment may be applied to any point g of a line which is perpendicular to the axis of the fibre, and Huyghens's elementary zones become elementary stripes parallel to this line.

Consider next the case (marked B in fig. 33) in which the point g falls on the boundary between two discs of different index. Let the shaded parts represent as before the wave-troughs which reach B, and the

unshaded parts the wave-crests; then the figure indicates the altered conditions as compared with the first figure for the case in which, corresponding to the different refractive indices of the two discs, the portion of the light-wave which has traversed one of them is retarded by an uneven number of half wave-lengths behind the other. It will be seen at once that $g\,f$ and $g\,h$ in their action on B cancel each other, as do also the other elementary strips, just as in the first case. Further, it will be seen that this extinction takes place for every point of the line independently of the distance g B, and that with an alteration in the thickness of the fibre a periodic alternation between light and partial darkness must take place. The case is different when we consider a point which is not at right angles to the bounding surface, e. g. C, fig. 33. The vis viva to be transferred from $f\,h$ to C is neither cancelled as in the second case, nor weakened in the same degree as in the first case by the neighbouring elementary stripes, whose phase is shifted through a half wave-length, but it reaches C, so far as concerns the portion $f\,g$, in its full extent, the action of $e\,f$ and $g\,k$ being added with positive sign to that of $f\,g$, though each of the first is weakened to a certain extent, it is true, by the slight action of $d\,e$ and $h\,i$. While therefore, the point B remains undisturbed, C receives an intensity of vibration, and a ray travels in the direction p C. This corresponds to the first diffraction pencil.

Supposing that the muscle disc $m\,g\,f\,n$ were much smaller, and extended from f only to a point, o (not shown in the figure), between e and f, if this thin layer is to have any effect upon the microscopic image it must, at least, contribute a diffracted pencil to the production of the image. The smaller $f\,o$, the farther must C travel from C_1, that the difference of path between the portions of the wave $f\,o$ and $f\,g$ may attain a half wave-length, and the larger, therefore, must be the angle made by the diffraction pencil with the perpendicular $n\,f$. When $f\,o$ is nearly a half wave-length, then this angle is nearly a right angle, and we get the law discovered by Helmholtz, that microscopic delineation ceases when the detail to be observed diminishes to the size of a half wave-length, presupposing an aperture of the Microscope of 180°. In this case one, at least, of the pencils of light diffracted by the structural element still enters into the microscopic image.

If we consider the boundary of the disc more closely, it is clear that there will be a similar interference upon the other side of $f\,n$. Here also there will be a ray in the direction p_1 C_1. Now, the two rays p C and p_1 C_1 have a difference of phase equal to $\frac{\lambda}{2}$. Focusing, therefore, upon the point of intersection of these two rays, we shall see a dark line under the upper surface of the fibre. If we focus the intersection of p C with the corresponding line $r\,q$ from the other surface of the disc, a bright band must be visible, as will also be the case when the Microscope is focused on the point above the fibre in which p_1 C_1 intersects the corresponding line (not shown) upon the other side.

The phenomena here described bear some relation, on the one hand, to the interference phenomena of the so-called 'mixed scales' discovered by Young, which are explained by the retardation of a part of the light-waves which traverse a medium of different refractive index from the rest; and, on the other hand, with the 'lamellar diffraction phenomena'

more recently investigated experimentally by Quincke and theoretically by Jochmann.*

The phenomena are, beyond comparison, more complicated in the muscle-fibres, as must be at once apparent if it is remembered that the conditions described do not depend upon $a\ b$ being the surface of the fibre, so that the above treatment holds good for any plane within the fibre for which the portions of the wave that traverse the different discs have a difference of phase equal to $\frac{\lambda}{2}$; and when it is remembered also that the phenomena must change with the thickness of the layer, that the source of light is not a point, but a bright surface (a portion of the sky or its image), that the light used is mixed light, &c.

The case may also be made clear in the following way:—When a plane wave traverses discs of unequal refractive index, it acquires parallel ridges corresponding to the layers of smaller index. The problem then consists in the determination of the resultant of the interference of the elementary waves proceeding from a surface of this form.

Some years ago Heppner† suspected that a certain layer of the muscle-fibre, identical with Rollett's N, does not in reality exist, but is confused through a reflex. Sachs‡ and others opposed this idea. Dönitz§ seems to have been the first who thought of diffraction phenomena as the explanation of certain striations. He was followed by Schäfer, and Ranvier made experiments upon the diffraction spectra obtained from stationary and contracted fibres in which the transverse striations acted as a diffraction grating.

I have, in the above remarks, raised the question whether, in the light of this optical treatment, the results of recent investigations have any value as regards the distinguishing of several layers in the muscle-fibres where previously two alone were recognized, or whether we must, with Abbe, for ever despair of recognizing such minute details.

My answer amounts to this, that without doubt the greater part of the recent results deserve complete trust. All those layers which have been distinguished, not only in the optical image, but also by maceration and staining experiments, are free from the suspicion of being only the impression of incomplete delineation. Rollett, who seems to have been thoroughly aware how slippery is the ground of simple microscopic examination, has recently, as I think, trodden the path here indicated with the best results. The same has been attempted, it is true, by many inquirers before him, but no one has worked in this direction with such a variety of methods or obtained such promising results.

When for example the layer N under the action of acid behaves in an essentially different way from the layer Q, there can be no doubt that a distinction is here established. But the case is different with certain details, where one meets with the above-mentioned want of care against incomplete delineation, in consequence of which one can see even *more* than is really present. I may be here allowed to give examples; but I may first state that in the absence of a true criterion for a correct and complete representation of the object, the following may serve as a criterion. A detail of the microscopic image is to be regarded as

* Cf. Verdet, 'Vorlesungen über die Wellentheorie des Lichtes,' German translation, by K. Exner, i. (1881).
† Arch. f. Mikr. Anat., v. (1869).
‡ Du Bois Reymond and Reichert's Arch., 1872.
§ Ibid., 1871.

existing in the object when its character is not altered by an inclination of the incident pencil of light (oblique illumination). If the character is altered in passing from central to oblique illumination, we may conclude that in the latter, diffracted rays enter the Microscope which were unable to do so in the first case. When this happens, it indicates that a complete representation is not obtained by central illumination, and it must be doubtful whether it is so by oblique illumination.

We may obtain a good idea of the optical processes which form the basis of this rule by means of the Abbe diffraction plate. If any line-system of the plate be so focused that the central image of the whole diffraction spectrum visible in the focal plane of the objective lies in the axis of the Microscope (direct illumination), and one entire half of the diffraction spectra be then screened off by a suitable diaphragm (with the exception of the central image for which the semicircular diaphragm must have a piece cut away), the microscopic image will not suffer any essential change. It is also possible, as may be easily seen, to set the mirror so obliquely (or to obtain oblique illumination by Abbe's condenser), that the rays which have not been diffracted still contribute to the microscopic image, the image of the source of light then falling at the margin of the diffraction phenomena visible through the tube. In this case still further diffracted rays may become visible in the diffraction image, and may contribute to the delineation if such rays are present to a considerable extent.

I cannot help calling attention to two other possible sources of error. It is not impossible that the discs of unequal index of which the muscle-fibre is constructed, are not separated from one another by sharp boundaries, but the optical density may change gradually from one to another. Such layers have in fact been described.

Now a disc in which the refractive index is a maximum or a minimum at the centre, acts like a cylindrical lens upon light which enters it parallel to its plane ends (independently of the cylindrical surface). The parts of a wave surface which traverse layers of smaller index, travel more rapidly than those which have to traverse layers of greater index, so that there results a cylindrical curvature of the wave surface.* In this way focal lines may be produced which are parallel to the layers in the muscle; they need not be outside the fibres, but may lie within them; in the first case they alter their position as the thickness of the fibre increases.

It is evident that stripes which are produced in this way, as well as those which result from diffraction, must undergo various changes if an alteration takes place in the refractive indices, owing to the separation of a liquid from the muscle-fibre. Since such changes do take place during the life of the muscle, it is not a matter for surprise if the fibres which are still contracting change their appearance. Rollett has in fact described and figured a series of such changes, but whether they are due to the causes here indicated, I must, in the presence of such a number of possibilities, leave undecided.

Mention has repeatedly been made of darker and lighter layers in the fibre, and Rollett, in treating of the transverse striations of the fibres, likes to give two figures beside one another, one taken with high,

* Cf. S. Exner, 'Ueb. Cylinder welche optische Bilder entwerfen.' This Journal, 1886, p. 1062.

the other with deep focusing, which bear the same relation to one another as the positive and negative of a photograph. They show that we have here a case of an optical effect. There are, however, frequently to be found figures in which the dark appearance of the striations is to be regarded as a true darkness of the anatomical structure; not the expression of diffraction, but an absorption of the light-rays. Sachs * says, 'The dark colour of the contractile substance rather depends principally upon the opposition offered by the very dense gelatinous mass to the passage of light; the greater part of the incident light between σ_1 and σ_3 is absorbed.'

Sachs is here speaking of the fresh living muscle-fibre,† in which the doubly refracting substance, at least under ordinary conditions and with the ordinary adjustment, does in fact appear dark. I must, however, deny this and similar statements to the effect that there is anywhere in the living muscle-fibre a substance which 'absorbs the greater part of the incident light.' All parts of the fibre which are not granular are rather to be regarded as absolutely transparent in layers of the thickness with which the Microscope is concerned, i. e. if there is an absorption it is not appreciable. The 'dark layers' which are not granular, and also, of course, the 'bright layers,' are always optical effects. If there were an appreciable absorption it would also be observed when the light travels parallel to the axis of the fibres. Since a reflection of the rays must take place where there are granules in the fibre, it is an open question whether light is absorbed by the granules.

The second source of error, which seems to me to be too much overlooked, takes effect when the fibres are examined in polarized light; not every bright line which is seen between crossed nicols is necessarily to be regarded as the expression of a doubly refracting layer.

The plane of polarization is also turned by diffraction, and it is impossible to say whether in this case the rotation of the plane of polarization does not also take place by refraction and reflection. In some fibres examined for this purpose I have found the maximum brightness from Q and Z between crossed nicols to be always in the same azimuth, which contradicts such an explanation of the layer Z which is generally regarded as doubly refracting.

Finally, there is one remark which I cannot refrain from making. It is fully established, in my judgment, as I have said, that there are living muscle-fibres for which the old idea of composition by alternate layers of singly and doubly refracting substance does not hold good; several layers can be distinguished. On the other hand, however, we must not ignore the fact that living fibres are observed in which only two old layers can be seen with certainty, and that this is the more certain in proportion as the fibres (assumed to be living) are more fresh.

It may well be asked what then is essential and typical in muscle-fibres. One may well hold the view that it is more natural to assume that in certain cases we fail to distinguish a part of the layers than to imagine an irregularity in the structure of the fibres. We must remember, however, that Rollett's investigations did not in general establish a type of numerous layers, but that the image varies from one

* Reichert and Du Bois Reymond's Arch., 1872, p. 633.

† This is not expressly stated, but follows from the fact that in the passage quoted he is opposing Heppner, who speaks expressly of the living fibre. Arch. f. Mikr. Anat., v. (1869) p. 139.

species to another, and what is not to be overlooked, that it varies considerably during the survival and decay, and during the process of hardening. In one preparation of living muscle-fibre from *Hydrophilus* I saw fibres in which the discs Z and E were well developed, by the side of others in which the distinction could not be seen.

With this want of constancy it seems to me to be dangerous to regard the fibre with nine layers as the type,* without granting that there also exist fibres with two layers. I am rather inclined to see the type in the fibres with two layers, and to regard the appearance of more layers as something secondary."

Method of Representing and Calculating the Magnification of Microscopic Objects in the projected images.†—Dr. P. de Vescovi has published a paper under this title, which seems to us to contain a great many elementary facts and statements. Divested of these, the following extracts appear to contain the pith of the paper.

The statement of the amplification rarely corresponds to the truth, and generally deviates widely from it, since the methods ordinarily used to calculate and to indicate the enlargement are defective, or at least fail in something. The amplifications given in the tables which are supplied with Microscopes are mostly obtained by multiplying the magnifying power of the eye-piece by that of the objective—an inexact method.

More exact are those who give the system of lenses used, and the names of the makers of the Microscope; but in this case if one considers the factors (such as length of tube), which contribute to the variations in size of the image, the indication is still inexact; as it may easily happen that with a given eye-piece and objective, and upon the same instrument, different amplifications may be obtained either of the real or of the projected image.

"To remove all uncertainty and possible difficulties, it is necessary that the explanation of every figure should give the following data:—

(1) The eye-piece and objective used.
(2) The maker of the Microscope.
(3) The length of the tube.
(4) The true dimensions of the object.
(5) The ratio of the dimensions of the object to those of its projected image, or the amplification of the drawing.

Example:—

Eye-piece 3. Objective AA Zeiss.
Length of tube = 17 cm.
Greater diameter of the object = 0·026 mm.
Amplification of the drawing = 95."

Measurement of Magnifying-power of Objectives.

[Replies to query by J. S. Hewitt, T. F. S., "Practical," E. M. Nelson, E. Holmes, "Gamma Sigma," J. D. M., and "Decem."]

Engl. Mech., XLVI. (1887) pp. 325, 341–2 (2 figs.), 365 (1 fig.), and 417.

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* So far as I know, no one has done this. Different authors have rather founded different types which always, however, have a considerable number of layers.

† Zool. Anzeig., x. (1887) pp. 197–200.

(6) Miscellaneous.

Development of the Compound Microscope.*—In the course of Mr. E. M. Nelson's paper on this subject he makes the following remarks :—"Let me preface the few remarks I have to make on the Development of the Microscope, by pointing out to you the important place the Microscope holds in our social economy. Up to a very few years ago the education of the nation was confined merely to a knowledge of Greek and Roman mythology. This was the key-note given by our two Universities, which as a natural consequence was followed up by the public schools, whose masters are all graduates of one of these Universities. The knowledge of a dead language depends more on an effort of memory than on a use of the reasoning faculty. As a development of the reasoning faculty is of vastly greater importance than the memory power, so dead languages are most unsuited for the training of the young. To educate according to its derivation, means to lead out; to educate a boy therefore, is to lead out his mind; in other words, to draw out something which is there. According to the popular notion it is to put in something which is not.

The only way to procure growth in an organism is to supply it with food it can readily digest, so the only way to develope the brain is to supply it with digestible food. Further, as one man's meat is another's poison for the body, so also is it for the mind. But what have the great educators of our nation done but force every one through the same classical diet, to the exclusion of everything else? In doing so they have ruined thousands of minds by arresting the development of the reasoning faculty, and by filling them with what is, in most cases, indigestible matter. There is necessarily a certain percentage of minds to whom classical lore is a food capable of ready assimilation; they consequently may be benefited by it, but we may assume the percentage is small.

You will be asking what all this has to do with the Microscope. To which I reply, that I wish to see Liddell and Scott's Lexicon dethroned, and the Microscope put in its place as a national educator. Of late a change has taken place. Since my schooldays, science has been introduced. This is the thin end of the wedge; let it by all means have full scope, and I have little doubt but that that science which was ridiculed by the schoolmasters of my day, will eventually supplant the Olympian mythology as a pabulum on which to feed the young mind. The Microscope and the telescope hold the same relation to science as a knife and fork do to beef. If science is a food for the mind, a little time devoted to the knife which makes it capable of assimilation will, I hope, not be in vain. Therefore, without further digression, I will at once pass to the instrument. The telescope, dealing as it does with extra-mundane things, cannot have the same interest for us as the Microscope. The one fact, that the Microscope has revealed the pestilence which has walked in darkness all these ages, is sufficient to place it above all other scientific instruments in importance. An unseen foe is a bad one to fight, but now that his lurking-place has been unmasked by the Microscope, we may look for some victories over our enemy. Have not some indeed been already gained?"

"We have now come to a period when the Microscope object-glass was achromatized, and from this date spring the great improvements

* Trans. Middlesex Nat. Hist. and Sci. Soc., 1886–7, pp. 103–11.

which have brought the instrument to its present state of perfection. It would, indeed, take several evenings to systematically examine the great number of forms which have been introduced since that time. It is my intention, however, only to notice three, as most of the others, not being of any practical value, have speedily become obsolete. We need no diagrams of the three forms which have survived, as I have actual examples in the room. First there is this, which is known as the "Hartnack," or "Continental Model," it is a lineal descendent of the "Oberhauser." I have little hesitation in saying that nine-tenths of all original microscopical work has been done by these Microscopes, but at the same time I maintain that that statement does not prove it to be the best model. It is a model which is incapable of doing critical work with low powers, and of working any high power at all. The reason why so many discoveries have been made with it is due to the fact that nine-tenths of the things discovered lie among low-power objects. Another point must be borne in mind, viz. that a quarter-inch lens uncritically used will as readily discover an object as a half-inch critically used.

The interpretation of images with low powers is easy, and requires very little training; critical images, therefore, are not so essential. Most of the fine high-power work which has been carried on with these instruments has been erroneous, and has had to be corrected with other instruments. As time goes on, discoveries with the low powers become less and less possible, and instruments of greater precision will become necessary."

"The importance of a condenser cannot be over-estimated. I have always held that Microscopy begins with a condenser. An instrument however well designed and well constructed, if it has not a condenser, is nothing more than a magnifying glass, while on the other hand, a simple stand like this iron one of Powell's, with a condenser, forms a very efficient Microscope."

'**Student's Handbook to the Microscope.**' *—This little book fulfils its purpose in a very creditable manner, and will be a useful guide for a large number of Microscope owners. It is a decided advance on the author's previous venture, 'My Microscope,' the publication of which was, we thought, to be regretted.

Even in these days it is, we suppose, hopeless to expect the question of aperture to be dealt with without a mistake, and therefore we find on p. 37, the statement that among the drawbacks to an excess of aperture is "a loss of defining power, that is distinctness of the image." This arises from an entire misunderstanding of the principles of aperture. The larger the aperture, the less the penetrating power, or the power of seeing a given depth of the object with the same focus. But the definition of the particular plane, whatever its depth, which is seen by the large aperture is not in any way impaired; in fact the definition of what is seen is more complete and perfect with the "high angle" objective than with one of smaller aperture.

"**Microscopical Advances.**" †—"T. F. S.," writing on one of a series of articles under this heading by Dr. G. W. Royston-Pigott,

* A Quekett Club-man, 'The Student's Handbook to the Microscope. A Practical Guide to its Selection and Management,' vii. and 72 pp. (30 figs.) 8vo, London, 1887.

† Engl. Mech., xlvi. (1888) p. 435.

points out that he has mixed up the "villi" on butterfly scales—which point to real structure—with the old vexed question of the beading of the *Lepisma* and *Podura* scale, "discrediting the whole thing with those who have knowledge of the subject, and giving utterly false impressions to those who have not."

Having carefully examined many scales of *Lepisma* with a fine 1/12 oil-immersion by Swift and Son, "T. F. S." is prepared positively to state that there is not the slightest existence of beads in any of them, although it is easy to see what caused the appearance of beads to Dr. Pigott with the dry 1/16 in. which he used. "Please remember," T. F. S. writes, "that it is a dry glass against an oil-immersion, and I need not tell any expert microscopist that if certain appearances which present themselves with a narrow aperture of the objective vanish when another of larger aperture is screwed on, that of itself is sufficient to disprove the existence of the apparent structure.

"Now for the real structure. The scale itself is composed of two membranes, in one of which is imbedded the longitudinal ribs; the other is corrugated, and the corrugations cross the longitudinal ribs at an oblique angle, giving under a low power the appearance of spines. Between the two membranes, and over the whole scale, is a net-like looking structure, perforated in all directions, and where this also crosses the oblique corrugations there is the appearance of beads. This appearance of beading, however, is confined to the sides, and not even Dr. Pigott himself could conjure any appearance of beading out of the centre, and in the drawing he has confined himself to the side only. Some of the small scales have only small straight hairs between the long ribs, and here it is easy to produce beautiful beads by using the smallest hole in the diaphragm of the condenser; but they all disappear on producing more light. On the *Podura* scale I have not been able to produce the slightest appearance of beading, although I have tried very hard to do so. The "villi" in the butterfly and moth scales stand on quite a different footing, and answer the purpose of keeping the two membranes more or less apart; but even here I can see no evidence of isolated beading. I can see them (the villi) on any scale with a dry 1/6 in. and 1/8 in.; but here the evidence is confirmed tenfold by substituting an oil-immersion 1/12 in."

"**The Microscope and Kidney Disease.**"—Most readers of newspapers are by this time sufficiently on their guard against the insidious paragraphs to be found at the bottoms of columns, the titles of which appear to promise a very interesting piece of news, but which ultimately end in an advertisement of some nostrum sold by the advertiser; such, for instance, as the "False Swain and Deluded Spinster," which in the last few lines is discovered to be an advertisement of a hair restorer.

A particularly flagrant example of this trap for the unwary was presented by the 'Norfolk News' of the 24th December last. The paragraph was not at the bottom but at the top of the column, and it was not printed in the usual smaller type, but in similar type to that used elsewhere in the paper. Being headed in capitals "The Microscope," and "The many Puzzling Secrets Revealed by this Wonderful Instrument," we naturally proceeded to read it with much interest, and that our readers may be able to participate in the feelings with which we followed the development of the atrocious nonsense thus

heralded we print it here, with the exception of the advertiser's name, for which we have substituted "Smith."

"No medical man of skill and ability considers his study at the present time complete unless it contains a first-class Microscope. This wonderful instrument by its marvellous power makes clear to our eyes a world of which, prior to its invention, we knew nothing. Its introduction into medicine is only of late years, and has been mainly brought about by the competition of practitioners in their endeavour to find some aid that would enable them to detect the presence of disease when hidden or masked; to diagnose with greater accuracy, and so secure that prominence in their profession upon which their fame and emoluments rest. But its use has been more particularly applied to the examining of the fluids of the body to determine the state of the kidneys, and to decide if the latter are in a state of disease, and, if so, its stage. It has already been the means of saving many a life in foreshadowing the advent of that stealthy and fatal disease to which Dr. Richard Bright gave his name, and which prior to the introduction of 'Smith's Cure' was always regarded as incurable. In all the history of the Microscope its use was never so prevalent, its study never prosecuted with so much vigour, as it is to-day; and science through its means is ever revealing something fresh and new in relation to its powers. For instance, a noted physician and German scholar has recently discovered that by its aid the presence of a tumour forming in the system can be detected, and if certain appearances are visible it is proof positive that the tumour or growth is of a malignant character. Uric acid, which is a rank poison, is one of the substances which arise from destructive waste of our body, and must be thrown off daily or we die. Now before we understood the Microscope it was impossible by any means at our command to know what was being passed out of our body, or from whence it came; and one great benefit which this instrument has conferred upon humanity is in the relief of headaches, malaise, indisposition, and other diseases, which are now known to be caused by the retention of uric acid in the body. When an analysis of the fluid is made by a micro-chemical examination this substance can be traced in its proper quantity, and when the proper remedy is applied relief is soon secured, the cure being effected almost immediately. . . .

As we said before, medical science has been unable to cope with this disease, and neither homœopathics nor allopathics are prepared with a cure for deranged kidneys; and all the world has long since recognized, and many medical men who are without bias and without prejudice, liberal minded, and anxious to cure, admit and prescribe 'Smith's Cure' as a specific for all diseases of the kidneys. . . .

'Smith's Cure,' like the Microscope, was found out by a layman outside the medical code. The universal testimony of our friends and neighbours shows it to be alone the remedy for all diseases of the kidneys, their prevention and cure. Their statements are sufficient explanation and endorsement of its extraordinary growth, and conclusive proof that it is perhaps the most munificent remedy known to the medical world since the Microscope revealed to us the all-important nature of the organs which this medicine is specifically designed to benefit."

Although from one point of view it may not be very complimentary, yet we must express a hope that the editor of the 'Norfolk News' when

he inserted this advertisement really believed that he was imparting to his fellow countrymen a sound and valuable piece of microscopical information.

"**Curiosities of Microscopical Literature.**"—In the last volume of the Journal, p. 830, we had occasion to comment upon a paper by Mr. H. Morland, in which a fundamental point of microscopical optics was the subject of an extraordinary misapprehension.

In the last number of the publication in which the original paper appeared, we find the following entry:*—

"Mr. Morland read a reply to a criticism in the Royal Microscopical "Society's Journal for the current month on his paper on 'Mounting "Media so far as they relate to Diatoms.'"

Neither the reply nor even an abstract of it is, however, printed, and no communication has reached us as to the nature of it. This is the funniest way of dealing with a "reply" that we can recall; it is framed somewhat on the principle of Leech's celebrated cartoon of Lord John Russell chalking "No Popery" on Cardinal Wiseman's door, and then running away!

Bary, A. de, Hon. F.R.M.S. Obituary Notice.
Athenæum, 1888, Jan. 28th, pp. 118–9. *Nature*, XXXVII. pp. 297–9.

Dancer, J. B., Death of.
["The death is announced of Mr. John Benjamin Dancer, a Manchester optician, to whom many important inventions are due. Mr. Dancer was born in London in the year 1812. He settled in Manchester in 1835, and soon made his mark in scientific circles. He was elected a member of the Literary and Philosophical Society, and a Fellow of the Royal Astronomical Society. He was the first to suggest the application of photography in connection with the magic lantern, and he followed it up by other improvements. He also constructed the optical chromatic fountain, an idea which has since been further developed at South Kensington, and Old Trafford, Manchester. Mr. Dancer's services in connection with electricity and photography were of a valuable and important nature. Further, Dr. Joule states that the first thermometer made in England with any pretensions to accuracy was constructed by the deceased. He was also successful in producing Microscopes which, while fully equal to the requirements of original research, were within reach of working-men naturalists. During the later years of his life Mr. Dancer's pecuniary circumstances were of a straitened character, and he also suffered from the terrible affliction of total blindness."]
Times, 7th December, 1887.

EDMUNDS, J.—**Theory of the Microscope—Nägeli and Schwendener.**
Engl. Mech., XLVI. (1887) p. 365.

ERRERA, L.—**La Micrographie à l'Exposition de Wiesbade.** (Microscopy at the Wiesbaden Exhibition.) *Bull. Soc. Belg. Micr.*, XIV. (1887) pp. 22–35.

EWELL, M. D.—**A Manual of Medical Jurisprudence for the use of Students at Law and of Medicine.**
[Contains chapters on the part which the Microscope may play in determining medico-legal questions.]
414 pp., 12mo, Boston, 1887.

FELL, G. E.—**Exhibition of "Letter O occupying space of 1/1,000,000 in. magnified 3200 times."** *Amer. Mon. Micr. Journ.*, VIII. (1887) p. 209.

HITCHCOCK, R.—**Reminiscences and notes on recent progress.**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 205–7.

Mayall, J., Jun.—**Conférences sur le Microscope.** (Lectures on the Microscope.) *Contd.*
[*Transl.* of the Cantor Lectures.]
Journ. de Microgr., XI. (1887) pp. 544–6 (6 figs.).

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* Journ. Quek. Micr. Club, iii. (1887) p. 197.

McIntire, S. J.—**Another Evening at the Royal Microscopical Society.**
[Description of the first Conversazione of this Session.]
Sci.-Gossip, 1888, pp. 19–20.

Nelson, E. M.—**The Microscope—Nägeli and Schwendener—English Translation, 1887.** *Engl. Mech.*, XLVI. (1887) pp. 325, 364–5 (2 figs.), 393–4.
Also comments by "Practical," who finds it "far too abstruse to be of practical value to the general body of microscopists" (*Ibid.*, p. 341), and reply by Dr. J. Edmunds (*Ibid.*, p. 365).—"A Fellow of the Royal Astronomical Society," who prefers Heath's 'Geometrical Optics' (*Ibid.*, p. 390).—Review by Dr. W. H. Dallinger (*Nature*, XXXVII., pp. 171–3).

Reichert, C.—**Directions for using the Microscope.** *Transl.* by A. Frazer.
[In the Translator's Preface acknowledgments are made to "Mr. A. Schulze (Fellow of the Royal Micro-copical Society)." No such name appears, however, in the Society's List of Fellows.]
12 pp. and 2 figs., 8vo, Edinburgh, 1887.

Royston-Pigott, G. W.—**Microscopical Advances. XXIX., XXX.**
[Butterfly dust; bars, villi, and bacilli; latticed and beaded ribs.]
Engl. Mech., XLVI. (1887) pp. 357, 379–80 (4 figs.).

Vorce, C. M.—**The Meeting of the American Society of Microscopists.**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 207–9.

Waterhouse, G. R., Hon. F.R.M.S. Obituary Notice.
Athenæum, 1888, January 28th, p. 119.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Cultivation of Saccharomycetes.†—Some fermentation experiments with which Mr. W. E. Stone has been engaged required the application of pure yeast, free from other organisms capable of producing fermentation, and the following was the method of separation and cultivation employed:—

A few drops of fresh beer-yeast were shaken in a test-tube with sterilized gelatin, which had been melted and cooled again until it was barely fluid. This flowed upon sterilized plates gave in twenty-four hours, at ordinary room temperature, a great number of colonies of Schizomycetes and Saccharomycetes, from which, with the aid of an ordinary dissecting Microscope, it was easy to inoculate new cultures. The gelatin was of ordinary composition in daily use in the laboratory, viz. 10 per cent. gelatin, 10 per cent. grape sugar, Liebig's "Fleisch Extract" added to give a yellowish-brown colour, and neutralized with sodium carbonate. Such a mixture is solid at 25° C.

For further culture the isolated gelatin-plate colonies were inoculated into sterilized solutions consisting of an extract made by boiling 200 grams of yeast in a litre of water, filtering, and adding 10 per cent. of grape-sugar. In such a solution an inoculation of a few yeast-cells usually increased in from twenty-four to forty-eight hours sufficiently to cover the sides and bottom of an ordinary 200 c.cm. flask with a thick white sediment. The cultures were most strong and active at the end of forty-eight hours. The supernatant fluid was then poured off, leaving the yeast deposit comparatively dry, 20 c.cm. of sterilized water added, and in this condition transfer to the sugar solution undergoing observation was easy by means of a pipette. By this method, and the use of the extract of yeast as a nutritive solution, pure cultures were repeatedly

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Bot. Gazette, xii. (1887) pp. 270–1.

obtained which excited as active a fermentation as the fresh yeast from the breweries, a result not always obtained by the use of artificial nutritive solutions. The original gelatin plate-cultures, on account of their rapid growth, were useless after thirty-six hours, and to avoid a constant renewal of the process, as well as the introduction of different species of Saccharomycetes, inoculations were made into gelatin tubes. The cultures thus obtained produced characteristic, elegant, ivory-white colonies of 3–6 mm. in diameter, and then further development ceased. In this state they retained their vitality, and were constantly referred to as a source of inoculating material for two months. Probably they remained vigorous much longer, as Saccharomycetes are well known to do, but at this time the author's need of them came to an end.

Improvement in the method of preparing Blood-serum for use in Bacteriology.*—Dr. A. C. Abbot fills a large vessel, which can be hermetically sealed, with blood taken directly from the neck of an animal, with the usual antiseptic precautions. It is then quickly closed and allowed to stand for 15–20 minutes until coagulation takes place; a sterilized glass rod is then introduced in order to break up any adhesion of the surface to the glass vessel. The vessel is then placed in a cooler temperature which should not be too low lest coagulation be interrupted. In 24–36 hours the serum is withdrawn with a pipette, and placed in a vessel closed with cotton wool. The latter is then packed in ice for at least three days in order to allow the coloured particles to subside. The clear part of the serum is then transferred in quantities of 60–75 c.cm. to sterilized flasks of 100 c.cm. contents. Discontinuous sterilization is then begun and continued for an hour a day for six consecutive days. For this, the temperature should never be higher than 64° C., nor lower than 58° C.; for at higher temperatures the serum loses its transparency, and at a lower one the microbes are not destroyed. Thus prepared, serum has been kept for a whole year in the laboratory of the Johns-Hopkins University.

Improved method for cultivating Micro-organisms on Potatoes.†—Dr. O. Katz recommends the following procedure for cultivating micro-organisms on potato, which he has found to give satisfactory results, especially in cultivations from dejecta of typhoid patients.

Test-tubes, 10·5 cm. high and 2·5 cm. in diameter, are plugged with cotton-wool and then sterilized in the usual manner. Potato slices cut out of medium-sized, oval-shaped, perfectly healthy potatoes, and about 1 cm. thick, are placed with forceps in the test-tubes, to the width of which they are made to fit. The tubes are then sterilized again at 212° F.

There is no fear of desiccation of the potato surfaces, as after boiling in the steam sterilizer, there is sufficient fluid at the bottom of the tube to keep the contents moist for a considerable time at a temperature from 20°–25° C. (68°–77° F.). At higher temperatures the development of micro-organisms is so much accelerated that there is no danger of desiccation, but if there should be any fear of its occurrence, the cotton-wool plug may be covered with an indiarubber cap.

In practice both sides of the potato are inoculated either from the same or from different colonies.

* Medical News, 1887, i. p. 207.

† Proc. Linn. Soc. N. S. Wales, ii. (1887) pp. 187–90 (2 figs.).

Method of preparing Potatoes for Bacterial Cultures.*—In order to meet the objections raised by E. Esmarch to the ordinary method of potato cultivation, Mr. M. Bolton, as he could not procure the Esmarch cells in America, adopted the following method in place of that proposed by Esmarch.

In test-tubes 4½ in. to 5 in. long, of 1 in. or more in diameter, were accurately adapted pieces of potato 2–3 in. long. The skins having been removed, the potatoes were cut up in an ordinary apple-corer. It was found advisable that one end of the potato-pieces should be cut obliquely, so as to offer as large a surface as possible, as in agar or serum tubes. At the bottom of the tube a drop of water is placed in order to prevent the potato from drying up. The tube is then carefully sterilized by steam.

Cultivation-bottle.†—Dr. H. Wilfarth uses, instead of the ordinary plate, for separating different kinds of bacteria, a flat flask of thin glass, much like an ordinary brandy bottle. The sides are round, parallel to one another, about 2–2½ cm. apart, and run pyriformly to a neck about 16–18 mm. wide, and sloping obliquely upwards. The neck is closed with a cotton-wool plug. The sterilized medium having been introduced and the inoculation made, the flask is laid on the flat side, and for microscopical examination under moderate powers it is turned over so that the gelatin layer is uppermost.

For liquefying colonies and for agar cultivations the bent neck of the flask renders it inconvenient for removing colonies for inoculation. The flask is filled by means of a separating-funnel, which only allows a certain quantity to flow in at a time.

Collecting and Cleaning Diatoms.‡—Mr. K. M. Cunningham, who states that he has been able to demonstrate 300 distinct species of diatoms from the immediate neighbourhood of Mobile, says that the first requisite in the preparation of marine diatoms is to secure a quantity of mud, and the subsequent treatment as pursued by the writer is as follows:—

Take at least half a pound of hard or soft mud to begin on, and soften it into a uniform liquid paste, and to hasten and assist its liquidity, add about a teaspoonful of aqua ammoniæ, which liquid will be useful in the initial steps of cleaning, as it cuts and dissolves slimy and gelatinous impurities, and cleans the sand-grains, and enables the bulk of the material to be cleaned to settle quickly and compactly, as well as having distinct lubricating properties. Next transfer the liquid mud to a suitable vessel of tin or china of at least six or more inches in diameter, and not over 5 or 6 in. deep; put therein as much liquid mud as will fill 1 in. in depth, and fill up the vessel with clean water, and stir rapidly the contents to liberate the flocculent matter from the heavier contents. After allowing the contents to settle for ten minutes, with a piece of rubber tubing, at least 18 in. in length, siphon off the water to within 1/2 or 3/4 in. of the bottom of the vessel, renew the water, and then stir quickly, and after five minutes again siphon off the water to within 1/2 in. of the bottom. The sediment left is transferred to any shallow tin or other vessel for convenience.

* Medical News, 1887, i. p. 318. † Deutsch. Med. Wochenschr., 1887, No. 28.
‡ Microscope, vii. (1887) pp. 331–6.

The next step is to place in a shallow concave glass used by photographers for crystal photographs, size about 4 by 6 in., a shallow layer of the diatomaceous mud, and, adding water, gently gig the glass to and fro, making the waves run from end to end, and tilting the off or front end. This manipulation forces the large and small sand-grains to densely cake and pack together, and at the same time forces to the surface a large percentage of the diatoms, and most of the vegetable débris. After a few moments of gigging, the surface fluid is gently poured off, and caught in a separate settling vessel, and the heavier sand dropped into a waste receptacle. It may here be observed that a very small percentage of matter would be the outcome of the first manipulation, and that the bulk of the material was removed from the crystal glass as rejected sand. It can generally be relied upon that what is left on the gigging-glass would not do to manipulate again, and the diatoms must be looked for in the light, coherent, flocculent, vegetable débris that floated over in the first removal of the surface fluid. Repeat substantially the same manipulation until the whole of the mud has been gone through, and in the little that is left of the original half-pound the coveted gems will be found, or do not exist. The next step is to deal with what has been saved in the various partial concentrations, transferring all of it to the crystal glass, adding clean water, and gigging it again several times in succession to remove additional sand, and to get a further concentration of the desirable material. An occasional wet test under the Microscope will show whether the indications of diatoms are good. If so, the material is then transferred to a small holder with a spherical bottom, so that it may quickly settle, and with a rubber bulb pipette all water is carefully removed. Should there appear to be about 1/2 in. deep of material as the result of all previous manipulation, add to it an equal bulk of sulphuric acid, intimately mix, and by the aid of the pipette transfer it to a 1/2 or 3/4 in. diameter glass test-tube of about six inches length; boil for fifteen minutes over a candle or spirit-lamp: in that time it is probable that all organic matter will be reduced or carbonized. At this juncture add carefully, a drop at a time, several drops of nitric acid, and boil continuously for ten minutes longer, when it will soon be noted that the blackness is discharged, transparency restored to the boiling fluid, a partial or complete bleaching of the material having occurred, together with a remarkable reduction in volume. If there have not been a complete reduction of all vegetable or other organic matter, it may be necessary to add a few drops more of sulphuric acid and boil it a while longer. Should the preparation at any time not yield satisfactorily to the bleaching process, pour out the contents in a spherical-bottom vessel, and allow time to settle; pipette off the acid, and add a fresh quantity of sulphuric acid, and boil a few moments, and finally add a few more drops of nitric acid to oxidize the remainder of the carbonized substances.

All acid-boiling processes should be conducted in an open fireplace if practicable, so that the irritating gases may pass up the chimney. The above apparently long or double boiling process is rarely required, but must be resorted to if the organic material to be reduced is refractory. Where boiling first in sulphuric acid, and later adding nitric acid, is applied to the cleaning of all diatom gatherings not badly mixed with sand or vegetable débris, or is applied to pure gatherings, it acts very rapidly, giving promptly a snowy-white cleaning of the diatoms. In

case of the marine or fresh-water diatoms, a final bleaching may be accomplished by pouring the diatoms, while still in acid, into a shallow and contracted glass or china saucer, and adding thereto a few drops of Darby's prophylactic fluid, which actively effervesces and liberates the bleaching gas. While the boiling alone, first in sulphuric acid and later adding some nitric acid will be sufficient, yet a greater whiteness is produced by the addition of the prophylactic fluid as a bleaching substance.

The boiling process above described dispenses with the addition during the cleaning of any powdered crystalline salts, and is also operated with a minimum of acid fluids, and to purify the diatoms from acids, it is merely necessary to allow the preparation to settle a few minutes and carefully draw off the bulk of the acid and allow the diatoms to settle in shallow china saucers, 1/2 in. preferably; draw off and change the water after one minute intervals, and repeat for four changes. A trial test made on a slide, dried over a flame, will show that all acid has been removed from the diatoms. At this stage there is a rich concentration of the diatoms, but included therein some sand-grains and flocculent soil; the flocculent matter is removed by repeated shakings and settlings through a few inches in depth of clean water at three minutes intervals, until when tested under the Microscope a satisfactory appearance is reached. The acid-cleaned diatoms are again transferred to the crystal gigging-glass and water added, and then very gently gigged for a final concentration of the diatomaceous forms and a further portion of fine sand removed. The finishing touch to the cleaning for concentration of the forms is done by placing a small quantity of the acid-cleaned and concentrated diatoms into a concave black or dark glass, such as is used in tourists' eye-glasses, and the contents gently oscillated from side to side and to and fro, when the diatoms will be found richly aggregated on the centre of the containing glass. The glass is then tilted and the diatoms removed by the gentle suction of a pipette, the dark glass enabling the mass of diatoms to be distinguished from the fine grains of sand adherent to the bottom of the glass. In lieu of the dark concave eye-glass, a deep bull's-eye watch-crystal makes a good substitute for the final act of concentration.

Diatoms are also richly concentrated from sand by simply spreading the containing fluid over either a six-inch square of smooth or ground glass, and gently gigging it while tilting it in the direction of one of the corners and allowing the fluid to run off into a proper receptacle. A large percentage of the sand-grains remain *in situ*, or adherent to the glass surface.

The author refrains from alluding to boiling in alkaline solutions to neutralize traces of acids as he has not found it desirable or necessary to do so; nor does he refer to flannel or silk strainers for the final cleaning and separation of diatoms.

BIRCH, H.—**Ueber Züchtung von Spaltpilzen in gefärbten Nährmedien.** (On the cultivation of Schizomycetes in coloured media.)
Tagebl. 60. *Versamml. Deutsch. Naturforscher u. Aerzte*, 1887, pp. 275–7.

RASKIN, M.—**Zur Züchtung der pathogenen Mikroorganismen auf aus Milch bereiteten festen und durchsichtigen Nährböden.** (On the cultivation of pathogenic micro-organisms on solid and transparent media prepared from milk.)
St. Petersb. Med. Wochenschr., 1887, pp. 357–60.

(2) Preparing Objects.

Preparing Ova of Amphibia.*—Dr. O. Schulze places the ova of amphibia (the investment derived from the oviduct having been removed) for twenty-four hours in chrom-osmium-acetic acid, or in chrom-acetic acid, and then washes them well with distilled water. At this point they are available for surface study. They are next immersed every twenty-four hours in spirit of 50, 70, 85, and 95 per cent., the latter being changed several times. Next in turpentine for one to two hours, according to the size of the ova. They are then transferred to paraffin (50°), whereof they have sufficiently imbibed in a half to one hour. It is noted that the time given must be carefully observed. The sections were fixed to the slide with some thin adhesive, and then after evaporation of the water treated in the ordinary way. Borax-carmine was used as the stain, and decoloration effected with acidulated 70 per cent. spirit (5 drops HCl to 100 c.cm.). By frequent change of this the yolk-granules were decolorized, and only the chromatic substance remained red.

Chrom-osmium-acetic acid cannot be used for fixing substances lying centrally in the egg.

Preparing Testicle for observing Nuclear Fission.†—Dr. W. Flemming's recent examination of cells was made on the testicle. The organ was very rapidly teased out on a slide, and the fixative dropped over it. Chrom-acetic-osmic acid five times diluted or Brass's mixture for Protozoa, used rather strong, were the media employed for fixing. The preparation having been repeatedly wetted with this fixative was transferred to a moist chamber for several hours; the preparation was thereby hardened on the slide, and bore washing with a gentle stream of water for half an hour. Staining was performed by dropping on a safranin or gentian solution, and then allowing the slide to stand in the moist chamber for some hours. The preparation was then washed, and dehydrated with absolute alcohol, to which a trace of hydrochloric acid was added if the osmium mixture had been used for hardening.

The advantages of this method are that the cells lie pretty close together, and are often very beautifully stained. On the other hand, the nuclear figures may be destroyed by the teasing, and the contents of various cysts are so commingled that the various stages of fission cannot be compared. For making sections the testicles were placed in strong osmic acid. Then prolonged and careful saturation with celloidin, for the capsule after hardening in osmic acid is penetrable with difficulty. Sections were stained with gentian or safranin. Hæmatoxylin was fairly successful, but the nuclear staining was rather dull. Removal of the celloidin improved the clearness of the pictures. For this purpose the section was first treated with bergamot, and this having been removed by drainage and bibulous paper, was replaced by oil of cloves, which gradually dissolved the celloidin. Then dammar. Before cutting, the lobule of the testicle was examined for evidence of nuclear fission; if found it would be present in the other lobules.

Demonstrating Cell-granules.‡—Dr. R. Altmann demonstrates cell-granules in the following manner:—The paraffin sections, stuck on mica-scales with alcohol in which a little gun-cotton is dissolved, are freed

* Zeitschr. f. Wiss. Zool., vi. (1887) pp. 177–226 (3 pls.).
† Arch. f. Mikr. Anat., xxix. (1887) pp. 389–463 (4 pls.).
‡ 'Studien über die Zelle,' 1886, Heft 1, 53 pp., 1 pl.

from the paraffin by means of xylol and alcohol, and then stained for about three minutes in a solution of acid-fuchsin (10 grm. of the dry stain dissolved in 66 grm. of water and 33 c.cm. of absolute alcohol added), and afterwards differentiated in a solution of picric acid (10 grm. picric acid, 150 c.cm. absolute alcohol, 300 c.cm. water). Over-action of the picric acid is prevented by the absolute alcohol. From the spirit the sections are transferred to bergamot oil and xylol. The mica-scale is not detrimental beneath the cover-glass, provided the preparation lies above it. Thus stained, the cell-granules are to be examined with oil-immersion lenses, weak ocular, and a powerful illumination. For demonstrating the granules by means of this staining process, fixation methods which the author is to describe in future are necessary.

Methods of Preparing Muscle for investigation.*—Mr. C. F. Marshall, in his investigations into the distribution of striped and unstriped muscle (see this Journal, 1887, p. 935), chiefly made use of Melland's method of gold-staining. The gold stains and renders evident the intracellular network of most cells, and especially the network of the striped muscle-cells. Melland's method consists in placing the muscle in 1 per cent. acetic acid for a few seconds; then in 1 per cent. gold chloride for thirty minutes, and then in formic acid (25 per cent.) for twenty-four or forty-eight hours in the dark. For more delicate organisms, such as *Hydra* or *Daphnia*, and the heart muscle of invertebrates, one hour's immersion in formic acid, exposed to strong sunlight, is the best treatment, as longer immersion in formic acid may lead to disintegration of the tissues. Control preparations were made with osmic acid. In many cases the examination of fresh tissues was useless; the special action of the gold-staining is to soften the fibre and so swell it out, while at the same time staining the network. With regard to this reagent, it is to be noted that the results obtained are somewhat uncertain; care must be taken with the time of action of the acetic acid.

Permanent Preparations of Tissues treated with Potassium Hydrate.†—Mr. B. L. Oviatt uses a solution of potassium hydrate of from 36–40 per cent. (potassium hydrate 40 grams, water 60·00); then this is replaced by a saturated aqueous solution of potassium acetate. Then add the staining agent, and then glycerin as a permanent medium. Heart muscle treated in this way five months ago is as perfect as ever.

Preparing Sections of Bone.‡—Dr. G. Chiaragi decalcified a strip of quite fresh bone (bird) in picro-nitric acid diluted with two volumes of distilled water and then placed it in spirit of increasing strength. The sections were then immersed for some minutes in a 1 per cent. solution of eosin and afterwards washed in a 3 per cent. hydrate of potash solution. The eosin stained the bone-cells and their processes, the rest of the bone being uncoloured. In order to fix the eosin, the sections were washed in a 1 per cent. alum solution. The sections were mounted in the alum solution.

Method of investigating Cristatella.§—Herr M. Verworn gives an account of his methods of working with *Cristatella*. The colonies were treated with 10 per cent. chloral hydrate solution for the purpose of

* Quart. Journ. Micr. Sci., xxxviii. (1887) pp. 81–2.
† St. Louis Med. and Surg. Journ., liii. (1887) p. 289.
‡ Bull. Soc. Cult. Sci. Med. Siena, iv. (1886) Nos. 8 and 9.
§ Zeitschr. f. Wiss. Zool., xlvi. (1887) pp. 100–1.

obtaining the polyps in an extended condition; they were put directly from the water into the solution, when the separate individuals generally contracted. But in a short time they gradually extended themselves again, and soon became insensible. In some cases chloral hydrate was added by drops. They were then put into a saturated solution of sublimate; after being for ten minutes in this, they were washed in water for half an-hour and then preserved in alcohol. The best preparations were thus obtained, and this method was distinctly preferable to killing them directly by alcohol or with osmic acid. Borax-carmine (with a small quantity of acetic acid) gave the best staining results, the preparations being subsequently treated with 70 per cent. alcohol and a few drops of hydrochloric acid. In the investigation of the living animals, F. E. Schulze's horizontal Microscope was found to be of great service.

Methods of studying Development of Eye of Crangon.* — Dr. J. S. Kingsley, in his investigations, hardened his eggs by Perenyi's fluid, followed by alcohol of increasing strengths; this is a process which works well with almost all arthropod tissues. In most cases they were stained entire with Grenacher's alum-carmine, but sometimes Grenacher's borax-carmine or Kleinenberg's hæmatoxylin was used. In later stages, when the deposition of pigment in the eye interfered with clear vision, the eggs were cut into sections, which were fixed to the slide with Mayer's albumen fixative. After melting the paraffin and allowing the sections to drop into the adhesive mixture, the imbedding material was dissolved in turpentine, and this was washed away with 95 per cent. alcohol. The sections were then covered with a mixture of equal parts of 95 per cent. alcohol and nitric acid, and after ten to fifteen minutes the pigment was removed. The slide was next washed with strong alcohol, and the sections stained deeply with Kleinenberg's hæmatoxylin, the excess being removed with acid alcohol in the usual manner. The sections were then mounted in balsam.

Preparation of Ascaris megalocephala.† — Prof. O. Zacharias, believing that the conjugation of male and female chromatin elements must be a very rapid process, was naturally led to distrust the slow fixing methods hitherto practised, and sought for a better. Fresh females were laid on a piece of wadding damped with 3 per cent. salt solution, covered with another of the same, put under a bell-glass, and incubated at 20° R. for two or three hours. Polar body formation and segmentation are thus stimulated. The separated organs are then placed in a fixing medium, the period being varied according to the age of the different regions of ova, and according to the character of the host. The youngest ova were only exposed for 5–7 minutes, the oldest for at least 25. After fixing in a mixture of acids (not yet disclosed), the ova were removed for 2–3 hours to absolute alcohol, and then placed in weaker spirit. Schneider's acetic carmine, and acidified aqueous solution of methyl-green, were also used. The ova were cleared in two volumes of glycerin to one of water.

Preparing Tape-worms for the Museum and the Microscope.‡— Mr. J. M. Stedman fills a hypodermic, or other syringe possessing a fine

* Journ. of Morphology, i. (1887) p. 49.

† Arch. f. Mikr. Anat., xxx. (1887) pp. 111–82 (3 pls.). Cf. *supra*, p. 43.

‡ St. Louis Med. and Surg. Journal, liii. (1887) p. 291.

sharp canula, with fine injecting mass, then the canula is inserted in the generative cloaca or opening of the vagina, thus cutting the excretory canal. If the canula is inserted the proper distance, the entire caudal portion of the water-vascular or excretory system can be injected. The injecting mass does not flow towards the head on account of the opposing valves. For the museum nothing further is done, except to wash the worm with water and suspend it in a bottle of 75 per cent. glycerin, to which has been added a few drops of acetic acid. The worm will soon clear up and show all the structures with the greatest clearness.

For microscopical preparations, one and a half or two segments, after treatment as above, are mounted on a slide in a cell of glycerin jelly. For the most satisfactory microscopical preparations, the ovaries and uteri, as well as the excretory system, should be injected. This is accomplished by first injecting the excretory system with one colour as described above, and then by employing another colour and forcing the canula further into the worm than when injecting the excretory system. Segments so injected may be preserved in glycerin jelly, or after gradual dehydration, in Canada balsam. Uninjected segments may be hardened in Müller's or Ehrlich's fluid, and then in alcohol, and made into serial sections to show the finer structural details.

Methods of studying Sphyranura.*—Prof. R. Ramsay Wright and Mr. A. B. Macallum found that specimens of *Sphyranura* were rarely too large to prevent complete study in the fresh condition. The most completely satisfactory reagent was Flemming's chrom-osmic-acetic mixture: an example being placed in water sufficient to cover it, a drop of the reagent was placed beside that in which the worm lies and the two were allowed to mingle, with the result that in five or ten seconds death, but not complete fixation, occurs. The greater part of the fluid being drained away the worm was gently straightened out with a needle, and a second drop of the reagent added for two or three minutes. The specimen must now be transferred to a larger quantity of the reagent, in which it must remain for thirty minutes, and it must then be passed through various strengths of alcohol from 30 to 90 per cent. Lang's Planarian fluid, and solutions containing picric acid cause shrinkage. Delage's osmic carmine has no advantage over Flemming's fluid. The process of imbedding used was the chloroform-paraffin method, the substitution of chloroform for turpentine having been found to obviate shrinkage of some of the delicate cells. Alum-cochineal was most satisfactory for staining specimens *in toto*.

Histology of Echinoderms.†—In making his observations on the minute anatomy of Echinoderms (see *supra*, p. 53), Dr. O. Hamann found that Flemming's chrom-osmic-acetic acid mixture was useful with the organs attached to the body-wall. With young and small animals chromic acid was used. Urchins preserved in strong alcohol were decalcified by placing small pieces in a 0·3 per cent. solution for a day, and washing them for twelve hours; these preparations took well the hæmatoxylin-stain. The pedicellariæ were either decalcified and cut, or were cut after treatment with Flemming's solution. The staining reagents used were, generally, carmine solutions; in the examination of glandular organs the anilin colours were useful. After treatment with

* Journ. of Morphology, i. (1887) pp. 4–6.
† Jenaische Zeitschr. f. Naturwiss., xxi. (1887) pp. 88–9.

absolute alcohol the preparations were cleared with bergamot oil or xylol, imbedded in paraffin, which was removed by xylol, and put up in Canada balsam to which xylol had been added. Xylol is to be preferred to such fluids as turpentine or chloroform.

Preparing Moulds.*—Mr. E. B. Wilson considers that although it is well known that the study of moulds may be greatly facilitated by following their development in gelatin films, or other solid substrata, spread on glass slides, yet that the value of the method for classes in elementary biology has not been sufficiently recognized. He therefore calls attention to the following application of the method, as simple and practical, and especially as affording a ready means of making very clear and beautiful permanent preparations.

The spores are sown with a needle-point in films, consisting of a modification of Pasteur's or Mayer's fluid (with pepsin) thickened with Iceland moss. In this medium moulds grow freely in the moist-chamber. They may be examined either fresh or after treatment with iodine, which scarcely colours the substratum. For the purpose of making permanent preparations the culture-slides are transferred directly from the moist-chamber to a saturated solution of eosin in 95 per cent. alcohol, a fluid by which the moulds are at once fixed and stained. After twenty-four hours (or, preferably, three or four days), the preparations are washed in 95 per cent. alcohol until the colour nearly disappears from the substratum, cleared with oil of cloves, and mounted in balsam. All stages may thus be prepared. The mycelia, conidia, &c., appear of an intense red colour, while the substratum is scarcely stained. Alcoholic fuchsin may be used instead of eosin, though inferior to it; but other dyes (of which a considerable number have been tested) colour the substratum uniformly with the moulds, and are therefore useless. Eosin preparations made more than a year ago do not yet show the slightest alteration of colour. The best results have thus far been obtained with *Penicillium*, *Eurotium*, and certain parasitic forms. *Mucor* gives less satisfactory preparations, since it is always more or less shrunken by the alcohol. Fair preparations of yeast may be made by mixing it with the liquefied medium and spreading the medium on glass slides, which, after solidification of the films, are placed in the eosin solution, as in the case of mould-cultures.

For preparing the cultures, Pasteur's or Mayer's fluid, with pepsin (see Huxley and Martin's 'Practical Biology'), but not containing more than 5 per cent. of sugar, is heated with Iceland moss until the mixture attains such a consistency that it will just solidify when cold (fifteen to thirty minutes). It is then filtered by means of a hot filter into small glass flasks, which are afterwards plugged with cotton-wool, and sterilized at 65° to 70° C. by the ordinary method. When required for use the mass is liquefied by gentle heat, poured on the slides, and allowed to solidify. The spores are sown by a needle-point, touched once to a mass of spores, and thereupon drawn across several films in succession, the spores being thus scattered along the track of the needle, and more or less completely isolated. Care must be taken that the quantity of sugar be not too great. The films should be tolerably thick, and the atmosphere of the moist-chamber such that the films neither dry nor liquefy.

* Amer. Natural., xxi. (1887) pp. 207–8.

Technique of Bacteria.*—M. Kunstler reports that either the vapour of osmic acid or the concentrated acid is a good fixing reagent for Bacteria. To show the flagella of *Spirillum tenue* it is necessary to mix a drop of osmic acid with a drop of the water containing the microbe, and to allow of a quarter of an hour's evaporation. Having covered it with a slip, a very small drop of a saturated solution of "noir Collin" is added near the middle of the four sides. The preparation is then carefully closed with wax, so as to prevent any evaporation. After some eight to fifteen hours the *Spirilla* become intensely coloured, and the flagella may be seen with moderate powers. At the extremity of the microbes there are four to six flagella. If, in addition to the "noir Collin," we add a little chromic acid, the body of *Spirillum tenue* presents a vacuolated, reticular, or areolated structure; the areolæ often contain granules. These appearances are best seen in specimens which are about to divide. In the other process of reproduction, M. Kunstler thinks the term of monosporous cysts to be preferable to that of spores. Good results are got by the use of a concentrated solution of hæmatoxylin, to which a little glycerin and chromic acid have been added. In some cases traces of potash are preferable to chromic acid.

(3) Cutting, including Imbedding.

Myrtle-wax Imbedding Process.†—Prof. W. H. Seaman says that Mr. J. H. Blackburn, in attempting to carry out the Reeves process of mounting,‡ failed entirely to get satisfactory results with what was sold to him by the local druggists as myrtle-wax, which he desired to try on the suggestion of Dr. Miller. On returning the wax, and stating that there must be some other substance called myrtle-wax, he received an article that gave perfect satisfaction, so much so, indeed, that he found it better than paraffin, and substituted it for that. Having been furnished with specimens, a short examination of its fusing point, &c., showed that it was the Japan wax obtained from the *Rhus succedanea*, now an extensive article of commerce. This substance is very peculiar in its great latent heat, giving it a wide range between the fusing and solidifying points. It solidifies without wrinkles, and sticks close to an imbedded object, qualities that render it especially valuable to the section-cutter. It is not strictly a wax at all, but a fat, since it consists chiefly of palmitic acid, and is capable of saponification. Mr. Blackburn showed whole brains saturated with it so perfectly, and preserved so naturally, except colour, that there seemed no reason why they could not be employed as models for class demonstration. To all appearances at the present time they are permanent. The substance may easily be obtained from the wholesale druggists.

Homogeneous Paraffin.§—Dr. G. A. Piersol says that much has been written regarding the necessity of having paraffin of the right consistence to insure success in cutting ribbon sections, but the desirability of having it *homogeneous* has been but little emphasized. The selection of a pure paraffin, freedom from turpentine or chloroform used in imbedding, and a very *rapid cooling* after the tissue is arranged, appear to be the essential conditions for securing this desirable character to the

* Comptes Rendus, cv. (1886) pp. 684–5.
† Queen's Micr. Bulletin, iv. (1887) pp. 33–4.
‡ See this Journal, 1887, p. 1048.
§ Amer. Mon. Micr. Journ., viii. (1887) p. 155.

imbedding mass. With a homogeneous paraffin it is surprising to see with what wide latitudes as to melting-point the chains of sections will come off.

Schiefferdecker's Microtome for cutting under alcohol.*—Dr. P. Schiefferdecker's improved microtome (fig. 34) is now provided with an arrangement for cutting under spirit, as well as for raising the knife-carrier and automatically raising the preparation. There are, besides, numerous practical improvements, but the principle of the instrument is unchanged.

The angle of the slideway and the weight of the slide itself are more favourable. Any slipping of the band from the wheel is now prevented, and the handle can be placed in any desired position. On drawing out the slide, the band can be so fastened that it always remains in the proper position.

Bending of the metal parts owing to refractory preparations is obviated, and the knife-guard is now so arranged that the pressure on the knife is as small as possible. In the illustration the arrangement for raising the knife is not seen, as it is covered by the pan. In a very simple way the knife-carrier is raised any required height merely by the crank action when the slide is drawn backwards. As the knife requires to be raised a shorter distance for paraffin preparations than for unimbedded ones, the arrangement for raising it is so effected that this action can be made at any desired position of the slideway. The position of the preparation is automatically altered, also, in a very simple manner.

A bar, which in its turn is moved by the crank, is set in motion by a toothed wheel acting upon a micrometer screw. Upon this bar is fixed a plate for regulating the amount or distance of raising. Expressed in fractions these amounts are 0·005, 0·01, &c., to 0·05 mm. For most cases these are sufficient, but if any other size be required the automatic arrangement may be dispensed with, and the preparation raised by turning the milled head of the micrometer screw with the hand. Of course any other denominator than 200 can be used for the fraction. For the automatic motion of the micrometer screw a new striking mechanism has been constructed, and this is found to be more effective than the catch arrangement.

The immersion apparatus is a flat quadrangular pan, in the bottom of which, and just above the preparation-clamp, is a circular hole for the preparation to pass through. The clamp, with the screws necessary for the two turns, is placed within a cylinder, the upper edge of which, by means of a short and wide caoutchouc tube, is united with a projecting rim running round the hole in the bottom of the pan, so that, when the spirit fills the pan and cylinder, the preparation always lies in the alcohol, and yet can be pushed up and down with the cylinder without difficulty. The screws which alter the clamp are turned with keys. The knife, which has a straight handle, is fastened by means of two screws to a thick metal-piece (the connecting-piece), and this in its turn is united by screws with the plate of the knife-carrier. The connecting-piece, to the under surface of which the knife is fastened, passes over the pan in such a way that it projects into the spirit.

UNDERHILL, H. M. J.—**Section-cutting applied to Insects.**
Sci.-Gossip, 1888, pp. 1–4.

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* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 340–3 (1 fig.).

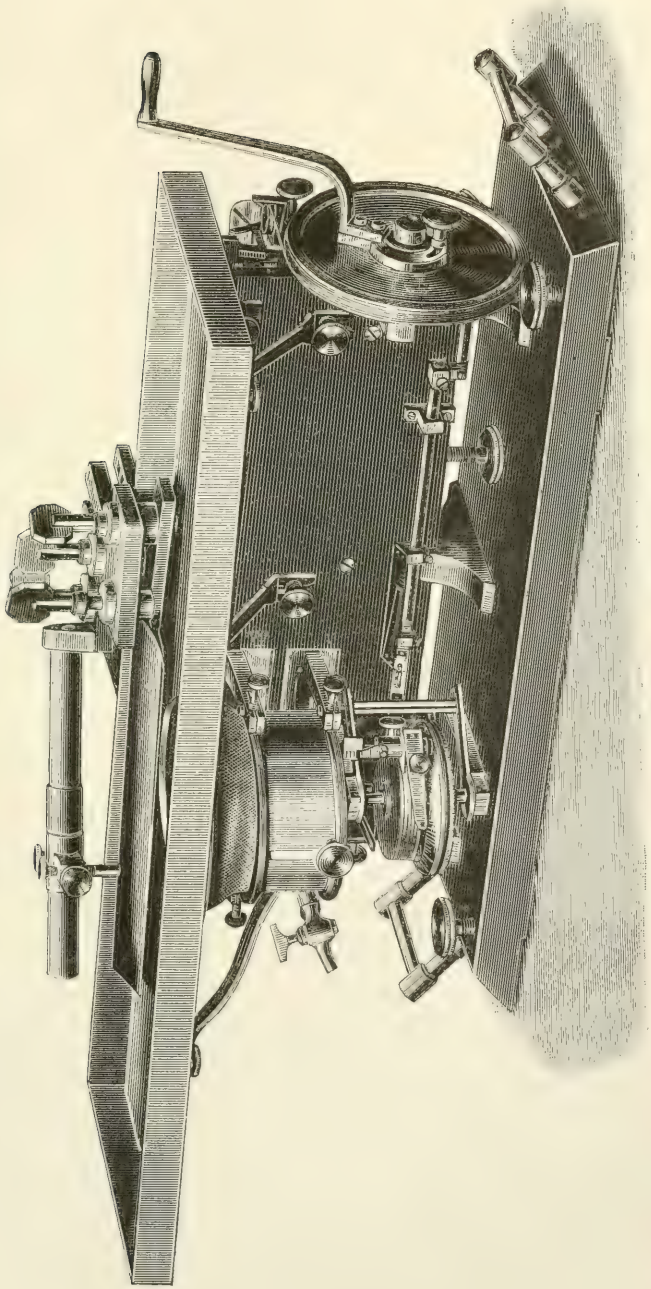


Fig. 34. Schieferdecker's Microtome for cutting under alcohol.

(4) Staining and Injecting.

Methods for Pathological Investigations.*—Dr. V. Babes uses a strong watery solution of safranin by dissolving the dye in distilled water to which 2 per cent. anilin oil is added. The mixture is then heated to about 60° C. and filtered while warm. The solution stains in about one minute; the sections are then passed through alcohol and oil of cloves and mounted in balsam. Hardening with Flemming's fluid is suitable for this method. According to the author this stain colours calcareous infiltration a red-violet, and is especially suitable for tissues containing bacteria.

The use of this safranin is also adapted for demonstrating certain pathological changes. For this purpose the tissues are thoroughly stained with safranin and are then placed for a minute in Gram's iodine solution. After passing through spirit and being mounted in balsam the colour is withdrawn, except from certain elements. For example, parts infiltrated with chalk and such as have undergone a colloid change remained stained. The iodo-safranin treatment is especially valuable for staining the club-shaped elements of the *Actinomyces*. The pus or the crushed *Actinomyces* is dried rapidly on a cover-glass and treated with anilin safranin for twenty-four hours, decolorized with the iodine solution, and mounted after dehydration and clearing up in clove oil.

The author also recommends a neutral anilin stain made up of a mixture of basic and acid anilins. This neutral stain consists of equal parts of acid fuchsin, methyl-green and orange, and is made by mixing 125 c.cm. of a saturated watery orange solution with 125 c.cm. of a saturated solution of acid fuchsin dissolved in 20 per cent. alcohol; to this 75 c.cm. of absolute alcohol and 125 c.cm. of a saturated watery solution of methyl-green are then added gradually. The sections are left in this staining fluid for half an hour, then washed and treated with alcohol and bergamot oil.

In sections thus treated the blood-corpuscles are orange-yellow, the nuclei of the polynucleated leucocytes green, and their cell-substance deep violet, the cell-substance of the eosinophilous cells blackish-brown.

Staining of Ossification Preparations.†—Dr. H. Klaatsch remarks that it is advantageous to possess a simple and reliable method for demonstrating the process of ossification to classes, for showing students the remains of cartilage in the newly-formed osseous tissue, and for distinguishing the difference between periosteal and cartilaginous ossification.

These objects may be attained by staining with logwood and decolorizing with picric acid. Grenacher's or Böhmer's hæmatoxylin may be used. Overstaining is of no advantage, but if it occur the section must be left for a longer time than usual in the picric acid. Students leave their sections overnight in a watchglass in a mixture of a little aq. destil. plus 6 drops of Böhmer's hæmatoxylin and 3 drops of glycerin. After being washed in distilled water the sections are transferred to a saturated solution of picric acid until they assume a yellowish-brown colour. They are next placed in glacial acetic acid for about half a minute, and are then washed in distilled water until the yellow colour is no longer

* Virchow's Arch. f. Pathol. Anat. u. Hist., cv. (1886) pp. 511–26 (1 pl.).
† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 214–5.

given off. They are then dehydrated, cleared up, and mounted in Canada balsam.

The preparations show the epiphysial cartilage to be of a dull pale blue, while the remains of the cartilage between the lines of ossification is of a deep blue colour. The newly-formed bone stains yellow, and the blood-vessels have a brownish hue. The permanence of the stain seems fairly good, as the author possesses specimens made six months ago which have undergone no perceptible change.

A modification of the foregoing method is also given. Instead of with hæmatoxylin the sections are deeply stained with methyl-violet and decolorized with picric acid until the blue colour is no longer given off. After being mounted in Canada balsam the sections look green to the naked eye. The cartilage remains, even to their least ramifications, are stained deeply blue and surrounded by yellow layers of bone. In the periosteal region the young bone-cells are of a greenish colour. The epiphysial cartilage is pale yellow. In this modification the histological details are wanting, and it is chiefly useful for demonstrating the difference between periosteum and cartilage ossification under low powers.

Staining the Elastic Fibres of the Skin.*—Dr. K. Herxheimer hardens his preparations in Müller's fluid; his method will, however, give good pictures after spirit, picric acid, and the chrom-osmic-acetic acid mixture. The sections should not be more than 0·2 mm. thick. They are stuck on with celloidin, and then stained for three to five minutes with hæmatoxylin (1 c.cm. hæmatoxylin, 20 c.cm. alcohol absolute, 20 c.cm. H^2O, 1 c.cm. lithium carbonate), but other watery solutions may be used. The sections are then treated for five to twenty seconds with chloride of iron solution. This last step requires some care. Mount in balsam. The elastic fibres stain a bluish-black or black, while the surrounding tissue is grey or bluish. By longer action of the iron, so that the connective tissue is quite decolorized and a part of the elastic fibres slightly pale, a contrast stain with carmine or Brunswick brown may be used with advantage. The method can be employed for staining the nervous system; for this two hours are required. Instead of hæmatoxylin the author also uses anilin water gentian-violet.

Staining Nerve-terminations with Chloride of Gold.†—Dr. G. Boccardi recommends the reduction of objects impregnated by Ranvier's or Löwit's gold chloride method to be done with oxalic acid of 0·10 per cent., or of 0·25–0·30 per cent. Another favourable reduction fluid consists of 5 c.cm. pure formic acid, 1 c.cm. oxalic acid of 1 per cent. and 25 c.cm. aq. destil. Pieces impregnated with gold chloride are to remain in this fluid in the dark not longer than 2 to 4 hours.

Demonstrating the Membrane of the Bordered Pits in Coniferæ.‡—Dr. A. Zimmerman states that this membrane only requires staining for its demonstration, and that hæmatoxylin is the best dye for the purpose; Bismarck-brown and gentian-violet are also capable of staining this tissue, but are inferior to logwood.

Material which has been preserved in alcohol is to be preferred. The sections are placed in Böhmer's hæmatoxylin for 2–5 minutes only, as a longer time stains the rest of the membrane, and it is advisable to

* Fortschr. d. Med., iv. (1886) pp. 785–9.
† Alboni Lavori eseg. nell' Istit. Fisiol. Napoli, 1886, Fasc. 1, pp. 27–9.
‡ Zeitsch. f. Wiss. Mikr., iv. (1887) pp. 216–7.

stain the cell-nuclei and the investing membrane of the bordered pit only. The preparation is then washed in water, dehydrated in alcohol, and cleared up in oil of cloves. Clearing up acts very beneficially, because the optical effect produced by the curvature of the pit is diminished.

The reaction of the bordered pit membrane to dyes undoubtedly shows that it differs in its chemical and physical relation from the rest of the membrane substance. The circumstance that membranes of the cambium cells and the membranes consisting chiefly of pure cellulose stain deeply with hæmatoxylin might lead to the conclusion that in the pit membrane we have to deal with a pure cellulose. This, however, is contradicted by the fact that it stains deep red with phloroglucin and hydrochloric acid.

Staining Diatoms.*—Prof. O. Drude discusses the method of staining diatoms as a suitable means for obtaining proper microscopical preparations. The methods which merely preserve the siliceous valves, and which at one time was the only object aimed at, have since Pfitzer's systematic classification (cf. Hanstein's 'Beiträge' and Schenk's 'Handbuch der Botanik,' ii. p. 403) have been recognized and adopted, no longer suffice, and must give way to a method which clearly shows and permanently retains in the microscopical preparation, the cell-nucleus and the endochrome-plates.

Such a method was communicated by Pfitzer four years ago,† and has been employed by the author with great advantage. It consists in staining the fresh material with picronigrosin: to a saturated watery solution of picric acid is added as much of a saturated watery solution of nigrosin as causes the mixture to assume a deep olive-green hue. This solution is poured over the fresh Bacillariæ, or the rotting leaves, stems, &c., of water plants on which they are found are placed in test-tubes filled with the picronigrosin solution. The first kills and fixes, the latter stains, the nucleus most strongly, less so the endochrome-plates, and very faintly the thin layer of protoplasm.

The stained valves are best mounted in balsam, after having been thoroughly washed with spirit, then dehydrated with absolute alcohol, and cleared up in oil of cloves. Thus are obtained very useful preparations which show beautifully the nucleus and nuclear fission, and also the endochrome plates which formerly soon lost colour or altered in form and position. Glycerin may be also used for mounting.

Stained Yeast-preparations.‡—Dr. P. Lindner states that the behaviour of yeast-cells to dyes is the same as occurs in Bacteria. If yeast-cells dried on cover-glasses be placed in solutions of methylen-blue, gentian-violet, fuchsin, Bismarck-brown, &c., they greedily pick up the dye. If the preparation be over-stained the mistake is easily obviated either by prolonged washing with distilled water, or by the application of spirituous or slightly acidulated water. The spores too behave in a manner similar to the resting spores of Bacteria. They are stained with difficulty; if this, however, take place, it is extremely permanent. For example, if they be stained with fuchsin, they may be washed for a long time, without being decolorized, while everything except the spores quickly loses its colour. In order to stain the mother and the sporeless cells e.g. blue, it is merely needful to immerse the

* SB. u. Abh. Naturwiss. Gesell. Isis, 1887, pp. 8–9.

† See this Journal, 1883, p. 445. ‡ Wochenschr. f. Brauerei, 1887, p. 773.

preparation in a solution of some blue dye. The red spores do not take up the blue pigment at all, while everything else is stained deeply blue.

Staining Lepra and Tubercle Bacilli.*—Dr. F. Wesener makes another reply to Prof. Baumgartner's criticisms on the methods for distinguishing between leprosy and tubercle bacilli. Throughout the controversy, no new facts have been adduced, and the gist of the whole seems to be that the one learned stainer prefers his own method to that of the other. They both seem to agree that tubercle, like leprosy bacilli, can be stained with simple solutions of fuchsin and methyl-violet; that there are, however, certain gradual differences between them, the leprosy bacilli taking up the stain somewhat more easily than the tubercle bacilli. Dr. Wesener distinguishes his position from that of Baumgartner by insisting that these gradual differences are very fluctuating, and not always constant, and on this ground that they are insufficient for a reliable diagnosis: the two methods given by Baumgartner for sections are specially unreliable.

As both these learned dyers have admitted that other data besides those of various stains (in so many words, it must be known beforehand which is tubercle and which leprosy tissue) are necessary for a certain diagnosis, it must be acknowleged that the main point in the controversy is one which requires special mental acuteness for its comprehension.

Specificness of the Tubercle Bacillus Stain.†—It is well known that Bienstock and Gottstein demonstrated the fact that certain non-pathogenic bacilli which stain in the ordinary way with anilin dyes could be so altered that they were able to be stained in the same way as tubercle bacillus. To effect this they were bred in agar-gelatin medium, to which about 20 per cent. of fat was added. Dr. A. W. Grigorjew has now tested Bienstock's conclusion, according to which tubercle bacilli owe their peculiar staining property to an investment of fatty matter, which prevents the decolorizing action of acids. The author cultivated in fatty media (1–20 per cent.) *Bacillus anthracis*, *B. subtilis*, *Clostridium butyricum*, *Bacterium termo*, *Staphylococcus aureus*, and *S. albus*. All these cultivations gave similar results. Bacteria lying in the fat stained as tubercle bacilli; those above or in islets free from fat stained in the usual way. Again, if the former class were acted on by potash, alcohol, or ether, their power of assuming the specific stain vanished, and they coloured in the usual way. The author further points to the significance which the mixing of a little fat with the bacteria on the cover-glass has. In this case the specific nature of the stain is lost. In this way it is even possible to impart the specific tubercle stain to a streak of albumen, and the author concludes that his experiments justify him in disbelieving Bienstock's explanation, and in supporting the existing theory as to the staining of tubercle bacilli.

New Staining Fluid.‡—Mr. J. W. Roosevelt recommends an iron stain, consisting of 20 drops of a saturated solution of iron sulphate,

* Centralbl. f. Bacteriol. u. Parasitenk., ii. (1887) pp. 131–5.

† Ruskaja Medizina, 1886, Nos. 42 and 43. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 251–2.

‡ New York Patholog. Soc., 9th March, 1887. Cf. Medical Record, ii. (1887) p. 84.

30 grams water, and 15–20 drops pyrogallic acid. The preparation assumes a brownish-grey colour. It is specially suitable for photo-micrographic purposes, because, when united with albuminous tissues, it undergoes no further change.

Benda's Modified Copper-hæmatoxylin.*—Dr. G. A. Piersol calls attention to the excellence of this reagent; though the method is troublesome the results amply repay where a careful study of cells under high powers is proposed.

Tissues treated with chromic acid or Flemming's solution stain readily, as well as do those hardened in alcohol or any other of the usual fluids. For careful examination, staining after cutting is advised: the sections on the slide or cover are placed for 8–12 hours in an almost saturated solution of cupric acetate (to which a few drops of acetic acid may be added) in the oven at 50° C., washed a few minutes in two changes of distilled water, and stained with 10 per cent. alcoholic solution of hæmatoxylin until very dark blue; transferred *directly* to hydrochloric acid solution (1:350), where they remain until bleached to a straw tint; after being rinsed in water they are placed in *fresh* copper solution until again blue. Should the sections be too dark they may be again bleached in the acid and passed through the copper solution as before; if too pale they are placed again in the hæmatoxylin and carried through the solution as at first.

The advantages of the method are certainty of good results after chromic acid, control of the intensity and ease of correcting faults of the stain, and above all, the excellent results. While the colour is less brilliant than the usual alum-hæmatoxylin stainings, the crisp, sharply-defined pictures furnished leave little to be desired, and to those seeking a precise and reliable stain after Flemming's solution this method is confidently recommended. Since the hæmatoxylin with care and occasional filtering may be repeatedly used, and as the copper solution is readily prepared and inexpensive, the method will be found economical and by no means as complicated in practice as on paper.

Action of Staining.†—Dr. M. C. Dekhuyzen holds, in opposition to Griesbach,‡ that staining is rather a physical process, as in the majority of cases only molecular combinations take place. He classifies the tissues (material hardened in 96° alcohol) as follows:—Mucin, primitive cartilage capsules (Ranvier), gland cells of fundus, cells of pyloric glands, Neumann's pericellular substance in cartilage, an imperfectly known constituent of nerve, and Henle's layer of the internal sheath of the hair-root are basophile, that is, possess an inclination for basic and a disinclination for acid dyes. The "acidophilous" constituents of tissues show the opposite behaviour, protoplasm especially, in covering cells ("Belegzellen") and in the lunules of Gianuzzi, connective-tissue bundles, elastin, decalcified bone, muscle, axis-cylinder, the peripheral layer of cartilage where the cells are flattened, and the secondary capsules of Ranvier which lie immediately upon the cartilage cells. Chromophilia is the property which both classes may have in common, although it is more marked in one of them. Chromatin and eleidin are chromophilous, and both have a preference for basic dyes.

* Amer. Mon. Micr. Journ., viii. (1887) pp. 153–5.
† Med. Centralbl., 1886, No. 51, pp. 931–2, and No. 52, pp. 945–7.
‡ See this Journal, 1887, p. 1058.

Modification of Schiefferdecker's Celloidin Corrosion Mass.*—Dr. F. Hochstetter has devised a modification of Schiefferdecker's celloidin corrosion mass, whereby crumbling of the mass and any brittleness after the addition of a large quantity of dye are prevented.

It is recommended to mix washed porcelain earth (kaolin) with celloidin. The porcelain earth is rubbed up with ether, to which cobalt blue, chrome yellow, or cinnabar is added. To this celloidin of the consistence of honey is added. The quantity of the kaolin to be used depends on the size of the vessel to be filled. If the whole distribution area of a vessel is to be injected, the syringe should at first be filled with a thin injection mass containing less porcelain; afterwards a thicker mass should be used. Teichmann's screw-syringe is the most suitable instrument for the purpose. A small quantity of pure ether is first injected; this done the mass is squirted in, at first pretty quickly, but afterwards more slowly, and the pressure of the piston-rod is kept up until the mass begins to set in the large vessels. This method may be advantageously employed for demonstrating the vessels in bone or those lying immediately upon it, but for "parenchymatous" organs this mass is not to be recommended. The preparations are macerated in the cold, bleached, &c.

HAMILTON, D. J.—**Method of combining Weigert's Hæmatoxylin-Copper Stain for Nerve-fibre with the use of the Freezing Microtome.**
Journ. of Anat., XXI. (1887) p. 444.

LIGHTON, W. R.—**Notes on Staining Vegetable Tissues.**
[Cut a fresh green stem and place the newly cut end in one of the usual staining solutions. The colouring matter will gradually be absorbed and distributed through the tissues.]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 194–5.

WASSERZUG, E.—**Principaux procédés de Coloration des Bactéries.** (Principal processes of staining Bacteria.) *Journ. de Bot.*, I. (1887) pp. 299–303, 321–4.

(5) Mounting, including Slides, Preservative Fluids, &c.

Fixing Sections.†—Of the three fixatives now in general use—shellac, collodion, and albumen—shellac is considered the best for objects coloured *in toto*. The carbolic-acid shellac introduced by Dr. P. Mayer has been found to be unreliable in some respects. Carbolic acid warm is injurious to some tissues, e. g. the dermis of vertebrates. The alcoholic solution is a perfectly harmless fixative. The method of using, now described by Dr. Mayer, and which differs in important points from the one prescribed by Giesbrecht, is as follows:—

(*a*) The object-slide, heated to about 50° C., is coated with shellac in the usual manner, by drawing a glass rod wet with the solution once or twice over its surface. As soon as the slide is cool and the film of shellac hard and no longer sticky, the sections are arranged dry, and then gently pressed down by means of an elastic spatula (horn or metal) until they lie flat and smooth on the slide.

(*b*) Expose the slide thus prepared to the vapour of ether. For this purpose the slide may be placed in a glass cylinder of suitable size, and closely stoppered. The cylinder is placed in a horizontal position, or, at

* Anat. Anzeig., 1886, pp. 51–2.

† Internat. Monatsschr. f. Anat. u. Physiol., iv. (1887) Heft 2. Cf. Amer. Natural., xxi. (1887) pp. 1040–1, and this Journal, 1887, p. 853, where the author's name was omitted through the note being separated from others in printing.

least, so inclined that the slide lies wholly above the ether. The saturation of the sections will be sufficiently complete in about half a minute.

(*c*) The slide is next to be warmed in the water-bath in order to evaporate the ether. The paraffin is then removed, and the mounting completed in the usual manner.

It is best to use balsam dissolved in turpentine or benzole rather than in chloroform, as the latter softens the shellac, and thus often loosens the sections.

One great advantage of this method of using shellac is that it permits of arranging and flattening the sections on the slide. Ordinarily sections are placed while the adhesive coating is soft, and must then lie as they fall.

With reference to collodion, Dr. Mayer remarks that it depends entirely upon the quality of the gun-cotton employed whether the sections bear well treatment with alcohol and aqueous fluids. When sections are to be stained on the slide, the albumen-fixative is preferred to collodion. The mixture is prepared as follows:—White of egg, 50 grm.; glycerin, 50 grm.; sodium salicylate, 1 grm. These ingredients are mixed and thoroughly shaken together, then filtered and kept in a well-cleaned bottle. Dr. Mayer has kept this mixture three years in a good condition. Other antiseptics have proved far less efficient than salicylate of sodium.

Substitute for Clearing.*—Dr. G. A. Piersol says that clearing with oil of cloves or other oil can be omitted where the sections are thin, especially when numerous and fixed to the slide or cover. If the sections be thoroughly dehydrated in strong or absolute alcohol, they may be mounted directly in balsam. The slide with the dehydrated section is removed from the absolute alcohol, hastily drained, a drop of balsam added, and the clean cover which is for a moment held over the flame is applied, when the slide is *gently warmed* over the lamp. There may be cloudiness at first towards the edges of the cover, but in a few minutes (with large sections somewhat longer) this all disappears. After a night in the oven at 40° C. these slides come out with covers so firmly fixed, that oil-immersions may be used and the covers cleaned with little fear of shifting.

Mounting in Canada Balsam by the Exposure Method.†—It has been a matter of surprise to Mr. G. H. Bryan that amongst the various methods of preparing microscopical slides, the so-called "exposure" method (due to Mr. A. C. Cole) of mounting in Canada balsam or other gum-resins, in which the balsam is partially dried before the cover is finally placed on the slide, has received so little notice, and he therefore desires to call attention to the advantages of this process for mounting almost all classes of objects, and also to describe a slight modification of it, by which means such arranged objects as sections in series, the various parts of an insect or other groups of objects may be mounted in balsam without difficulty.

The following is a brief outline of the exposure method:—Breathe thoroughly on a glass slip, and on it drop three clean covers, which will thus adhere temporarily to the slip, or, if preferable, each may be let fall

* Amer. Mon. Micr. Journ., viii. (1887) p. 155.
† Scientif. Enquirer, ii. (1887) pp. 184–6.

on the tiniest drop of water. On each cover let an object be arranged in a moderately convex drop of balsam, extending *to* but not *over* the edge of the cover. Then put the specimens away for the balsam to dry for at least twelve hours in a dust-proof box.

When the covers have been exposed long enough, they may be turned over on to warmed slides, but must not themselves be warmed first. The danger of large air-bubbles is diminished by placing or smearing a little fresh balsam on the slide, and this *must* be done if there is not enough balsam on the cover. If possible, the cover should be held in a pair of forceps and lowered *horizontally* over the slip, not on one side first. It is then less liable to tilt, and the fresh balsam is squeezed out symmetrically round the edge on pressing the cover down, and can mostly be at once taken off with a knife, and the slide then cleaned with spirit, the part under the *middle* of the cover being filled with the exposed balsam, which is generally firm enough to keep from slipping. In any case, the small amount of soft balsam around the edge will soon dry after the rough scraping, thus avoiding the long waiting required before cleaning slides mounted in the usual way.

For mounting arranged objects, we may proceed as follows:—The cover being stuck by breathing to a slip as before, the objects are all neatly arranged on it in the layer of balsam, which should not be too thick. The cover must now be exposed till the balsam is nearly or quite *hard*—a week's exposure or longer may be requisite. The covers must be turned over on to a *cold* slip into a drop of soft balsam and pressed down, the objects being fixed in their places on the cover by the hardened balsam, which is undisturbed. Scrape off the superfluous soft balsam, and put away to dry. The streaky appearance due to the two densities of balsam will soon disappear.

The author has tried the above methods with great success for mounting whole insects, and parts of insects, under pressure. For preparing whole insects for mounting, it is best to soak in potash, wash in water with a few drops of acetic acid, flatten out with two pieces of glass, which are tied together while the specimen is soaked for a further period in acidulated water, then in alcohol. Untie the glasses, float the insect on to a cover-glass and take it out, drain off superfluous alcohol, lay the cover on a slip, add a drop of clove-oil, which will permeate the object, and the alcohol will mostly evaporate in half an hour or more. Most of the superfluous clove-oil may then be drawn off with a pointed tube and the balsam applied. Parts of insects may be lifted from the alcohol into a vessel containing clove-oil, and afterwards taken out and laid out in the balsam on the cover. In this way he has mounted twelve parts of a honey-bee neatly grouped on one cover, and several other "typo" slides, and he thinks it will be found that these methods remove the chief difficulties of mounting in balsam, and especially of mounting arranged slides.

BUFFHAM, T. H.—[Arranging Slides.] *Engl. Mech.*, XLVI. (1887) pp. 396–7.

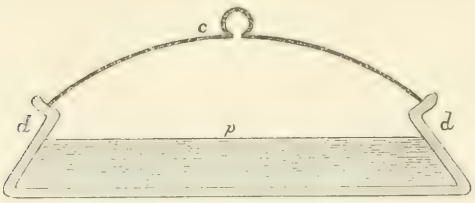
(6) Miscellaneous.

Dissecting Dish.*—The following is taken from one of a series of articles on "the Naturalist's Laboratory" in course of publication in the journal noted at foot.

* Knowledge, xi. (1887) pp. 278–9 (1 fig.).

The dissecting dish, as its name implies, is useful for animals of small size only, such as earthworms, snails, frogs, &c. Although an ordinary pie-dish can be, and has largely been, used for this purpose, it is unquestionably a very imperfect article. Let us take, for example, a frog: to learn its anatomy thoroughly, several days of work should be spent upon its dissection. The dish should be filled to the depth

Fig. 35.



c, cover; *d*, body of dish; *p*, bed of paraffin.

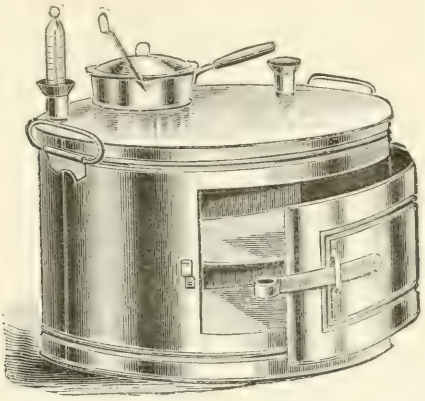
of about $1\frac{1}{2}$ in. with a suitable mixture of paraffin wax and hog's lard, melted together at a low temperature, and poured, whilst still fluid, but on the verge of becoming solid, into the dish; this will prevent any marked after shrinkage. The animal should next be fastened upon the paraffin when solid, with pins, and covered, or partially covered, with dilute spirit. After a day or two, when some critical portion is about to be examined, the student often finds, to his chagrin, that the liquid around his dissection has insinuated itself between the sides of the dish and the edges of the paraffin bed, by an almost imperceptible shrinkage of the latter, sufficient, however, to render it so unsteady as to preclude the possibility of work except with the utmost difficulty. To obviate any such mishaps, the (anonymous) author has devised a dish, shown in section at fig. 35. It may be oval or oblong (preferably the latter) in shape; its sides slope upwards and inwards, and thus effectually prevent the bed of paraffin from shifting or floating during the dissection. The upper rim of the dish should be indented, so as to admit of a cover which will not easily slip off. Both dish and cover may be made of earthenware, of indurated wood, or the new paper bottle material invented by Mr. H. L. Thomas.

Artificial Serum for Computation of Blood-corpuscles.*—M. Mayet finds that the disadvantages of deformation, &c., which attend the use of all the liquids employed in the computation of the number of blood-corpuscles, may be avoided by using an artificial serum of the following composition:—distilled water, 100 gr.; pure anhydrous neutral phosphate of sodium 2 gr.; and cane-sugar to raise the density to 1085. The form of the elements is preserved; the density, slight viscosity, and the presence of a neutral alkaline salt secure uniform distribution of the elements; the differences of level avoided in a less dense medium are of little importance; by altering the focus the leucocytes appear quite distinct as brilliant bodies.

* Comptes Rendus, cv. (1887) pp. 943-4.

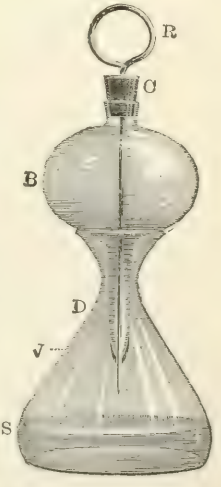
Reeves's Water-bath and Oven.—The arrangement of Dr. Reeves's apparatus sufficiently appears from fig. 36. It is heated by a gas-burner, or placed over a coal-oil flame.

Fig. 36.



Doty's Balsam Bottle.—Most of the methods for the manipulation of Canada balsam are open, it is said, to the objections of inconvenience, wastefulness and slowness which Mr. Doty's bottle, fig. 37, is intended to obviate.

Fig. 37.



The reservoir B is a turnip-shaped bulb, through the stopper C of which passes a wire R. One end of the wire is then bent into a ring for the finger, and the other is tapered and ground into the lower end of the stem of the bulb, thus forming a valve V.

In preparing for use, first put a small quantity of the solvent S, which is used to dilute the balsam, into the bottle D, being careful that not enough is used to touch the valve; remove the wire and stopper from the bulb and close the valve end; fill the bulb with balsam diluted so as to flow or drop freely, and replace the wire and stopper.

The advantages of the bottle are:—The bulb can be taken from the bottle and operated with one hand; the balsam is always ready to flow and will not harden at the exit of the bulb; the flow can be perfectly controlled; it may be operated continuously; it is cleanly and durable; the balsam being delivered from the lower end of the tube is free from bubbles, and being always protected is free from dust.

Eternod's Apparatus for stretching Membranes.*—Professor A. Eternod's apparatus for stretching membranes consists of a nest of rings

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 39–41 (2 figs.).

(fig. 38), each of which is slightly conical (fig. 39), so that the one fits into its neighbour very easily. The upper side has a bevelled edge *c*, which prevents too extended a contact of the membrane with the inner ring when the membrane is stretched. The rings are made of vulcanite, a substance which is not attacked by the ordinary reagents, such as spirit, Müller's fluid, acids, &c. When stretched on these rings, the object M—mesentery, epiplasm, &c.—may be placed beneath the Microscope and subjected to stains or fixative or other reagents, such as nitrate of silver.

Fig. 38.

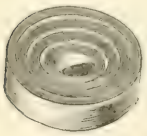
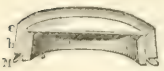


Fig. 39.



Determination of the Number of Trichinæ or other Animal Parasites in Meat.*—This is thus effected by Prof. H. Gage:—After meat has been found to be infested with parasites, if it is desired to determine the number in a kilogram, pound, or any other weight, a section of the meat is made with some sharp instrument, and the thickness of the section is measured by placing it between two cover-glasses whose thickness is known, and then, after pressing the cover-glasses quite firmly together, measuring the entire thickness. The thickness of the section of meat is then easily determined by subtracting the thickness of the cover-glasses from the number representing the thickness of the cover-glasses and the meat. The sections may be from 0·1 to 0·3 mm. in thickness. Remove the upper or eye-lens of the ocular of the Microscope, and place on the diaphragm a piece of paper in which a small square opening has been made, thus converting the diaphragmatic opening from a round to a square one. Replace the lens, and by the aid of a stage micrometer determine the value of one side of the square field thus made. The opening need not, of course, be square, but it is much easier for most persons to determine the area of a square than a circle—hence a square is recommended. Put the section of meat under the Microscope and count the number of parasites in the field, moving the specimen and making twenty or more counts, in order to get an average which shall fairly represent the number of parasites in one field. Find the cubic contents of one field by multiplying the thickness of the section by the number representing the value of the sides of the square field. From this compute the number of parasites in an entire cubic centimetre. Divide this number by the specific gravity of muscle (1·058), and the result will give the number of parasites in one gram of the meat. From this the number in one kilogram may be obtained by simply adding three cyphers (multiplying by 1000), or in one pound avoirdupois by multiplying by 453,593, which is the number of grains in one pound. The following is an example:—

The thickness of the section was 0·27 mm., and the value of the square field as seen in the ocular was 1·5 mm. The average number of *Trichinæ* seen in this field in twenty observations of different portions of the meat was three. The cubic contents of the field was $0{\cdot}27 \times 2{\cdot}5 \times 1{\cdot}5 = 0{\cdot}6075$ cub. mm. If 0·6075 cub. mm. contains three *Trichinæ*, one cub. mm. will contain 4·038 of them, and a cubic centimetre or gram would contain 1000 times as much, or 4938 *Trichinæ*, providing it weighed only as much as distilled water at 60° F. But as muscle weighs

* St. Louis Med. and Surg. Journal, liii. (1887) pp. 289–91.

1·058 as compared to water, the true number would be 4937 × 1·058 = 4667·3 in one gram, or 4667·300 in a kilogram, or 4667·3 × 453·593 = 2,117,054 in one pound avoirdupois.

Models in Metal of Microscopical Preparations.*—Prof. E. Selenka prepares metal models from microscopical preparations in the following way:—To obtain a plaster representation of the brain of a vertebrate embryo, the outlines of the head, the external and internal boundary lines of the brain are drawn on paper from the specimen with a camera lucida. According to the size of the separate sections, every second, third, or fourth section is selected, the drawings are numbered, and then carefully stuck on cardboard of the necessary thickness; the reverse side of the cardboard is covered with glue. The separate figures are then carefully cut out. Small strips for joining must of course be left in the brain. The different layers of cardboard are then glued together in their proper order, and thus a case model of the head is obtained. Any gaps or seams on the surface are filled in with plaster of Paris, and then the hollow model, which is open behind, is filled with Wood's metal heated to about 75° C. When cool the cardboard is softened in lukewarm water and then stripped off. The model is next cut in two with a fret-saw and the internal surface of the brain freed from the cardboard. Unevenness of the surface and holes are easily got rid of with a heated needle or knife, or by touching up with a stick of Wood's metal which has been softened at a gas jet. It is necessary to leave vent-holes in the cardboard model.

New Reagent for Albuminoids.†—Dr. M. Kronfeld proposes a new test for the presence of albuminous substances, viz. *alloxan* (= mesoxalylurea). This substance forms crystals which are readily soluble either in water or alcohol. From a *hot* solution there are deposited small permanent crystals with 1 equivalent of water; the larger crystals which are obtained from a *warm* solution deliquesce in the air. Solutions of alloxan produce, with albuminoids, and with some of the products of its decomposition, a red colour, which passes into purple, with an unpleasant odour. The reaction is obtained with tyrosin, very intense with asparaginic acid and with asparagin; apparently with all those compounds which contain in their molecules the group $CH_2.CH(NH_2).CO_2H$.

Solutions of albuminoids give the reaction more slowly than when in the solid form. In order to be certain of success it is necessary to operate in the cold, and to exclude as much as possible the presence of ammonia; solutions in alcohol, water, or in caustic soda may be used. Free acids prevent the reaction. The endosperm of seeds, which contains aleurone and sphærocrystals, is very convenient for experimenting with the alloxan-reaction.

White's Elementary Microscopical Manipulation.‡—Whilst it might be thought that the ground was already fully occupied for works on microscopical manipulation, Mr. T. Charters White's excellent little book will be found to meet a distinct want. More extensive treatises of course exist, but this, in the words of the author, "is designed with the aim of affording the youngest beginner such directions for preparing

* SB. Physiol. Med. Soc. Erlangen, 1886, Heft 18.

† SB. K. Akad. Wiss. Wien, xciv. (1887) p. 135.

‡ White, T. C., 'A Manual of Elementary Microscopical Manipulation for the use of Amateurs,' iii. and 104 pp., 1 pl. and 6 figs. 8vo, London, 1887.

objects of interest and instruction in an elementary but at the same time such a complete manner that, be he the merest tyro, he may grasp their details and work out his studies with the most satisfactory results."

Brun, J.—**Notes sur la Microscopie technique appliquée à l'histoire naturelle.** (Notes on microscopical technique applied to natural history.)
Arch. Sci. Phys. et Nat., XVII. (1887) p. 146.
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4th ed., 266 pp. and figs., 8vo, Paris, 1887.

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Amer. Mon. Micr. Journ., VIII. (1887) pp. 203–5.

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217 pp. and 126 figs., 8vo, New York, 1887.

[Osborn, H. L.]—**Microscope in Medecine.**
Amer. Mon. Micr. Journ., VIII. (1887) p. 217.

Piersol, G. A.—**Laboratory Jottings.**
[Fixing reagents (chromic acid the best). Benda's modified copper-hæmatoxylin (*supra*, p. 158), Celloidin *v.* Paraffin. Homogeneous paraffin (*supra*, p. 151). Dispensing with clearing (*supra*, p. 160).]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 153–5.

Strasburger, E.—**Microscopic Botany.** A Manual of the Microscope in Vegetable Histology. *Transl.* by A. B. Hervey.
[Translation of 'Das Kleine Botanische Practicum.']
382 pp., 8vo, Boston, 1887.

Taylor, T.—**The Crystallography of Butter and other Fats.** IV.
Amer. Mon. Micr. Journ., VIII. (1887) p. 226 (2 pls.).

Ziegler, E.—**Die Technik der histologischen Untersuchung pathologisch-anatomischer Präparate.** (The technique of the histological investigation of pathologico-anatomical preparations.) 8vo, Jena, 1887.

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Moniteur du Praticien, III. (1887) pp. 125 and 158.

PROCEEDINGS OF THE SOCIETY.

Meeting of 14th December, 1887, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 9th November last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Dallinger, Rev. W. H., LLD., F.R.S., The Creator, and what we may know of the method of Creation. 38 pp. (8vo, London, 1887)	*The Author.*

Mr. Crisp read to the meeting the preface to Dr. Dallinger's book.

The President said, that although it would not be imparting anything new to the Fellows to remark upon the fact of the removal by death of Mr. Bolton since their last meeting, he thought it was fitting to make public allusion to the fact in that room. Microscopists generally were greatly indebted to him for the measures which he had adopted to enable them to study a great variety of living objects. His friends moved the Government to grant him a small pension for the services he had rendered to science, but unfortunately he only lived to enjoy it for a very short period. Both as individuals and as a Society they would record his death with sorrow.

Mr. J. Mayall, jun., described two Microscopes by Jaubert, one of which had been described in the Journal for 1887, p. 632, and the other had not yet been described.

Mr. Michael said that, a short time since, his relative, Mr. W. H. Michael, who was an excellent chemist, drew his attention to the *Oleum Rhodii* as being a substance very likely to prove advantageous as a substitute for oil of cloves in cases where this was usually employed in the preparation of objects for mounting. He had tried it for a few months, and it had given results sufficiently satisfactory to induce him to bring it to the notice of the Society. "Rhodium oil," as it was commonly called, was supplied by chemists who sometimes thought it had to do in some way with the metal Rhodium. It was, however, obtained from *Rhodium Radix—Rhodium* being a thorny shrub growing in the Canary Isles. The oil was prepared by distillation, and was used for two widely distinct purposes. Firstly, the refined quality was largely used in this country by perfumers, as diluted attar of roses; and secondly, the commoner kind was used by rat-catchers on the Continent for the purpose of attracting rats, which were said to have a great partiality for it. Its value for mounting purposes was suggested to him on account of its being an oil of high penetrating power, and at the same time not being volatile. He had used it for about two months on *Acari*,

and found that it had three great advantages. First, when a delicate object had been prepared in spirit and was afterwards transferred to oil of cloves it usually shrank back in a degree that was often detrimental: Rhodium oil did not cause it to do this. Second, when a very delicate object with small passages had been in oil of cloves it was often found that the oil of cloves ran out quicker than the balsam ran in, resulting in an appearance as if air had got into the tissues: this was avoided by the use of Rhodium oil. Third, an object could be transferred direct to this oil from water or dilute acetic acid without the necessity of passing it through spirit. It gave as good results as oil of cloves, and rendered mounting in the last named respect a somewhat less troublesome process.

Mr. Karop inquired if Mr. Michael had tried it upon anything else than insect preparations? It seemed to him somewhat strange that an essential oil should be miscible with water.

Mr. Michael said he had tried it upon a few other objects, but had not much histological work to try it upon at present. He found that it did not produce any milkiness in objects transferred to it from water.

Mr. Suffolk asked if it was easily procurable?

Mr. Michael said he thought it could be got at almost any chemist's, especially such as supplied materials to perfumers; but the finer quality should be asked for.

The President said he was not yet able to give any practical account of the piece of apparatus which he held in his hand, but he thought the Fellows present would be interested to know that it was the first condenser made with the new German glass. It had a numerical aperture of 1·4, working at the same distance as the achromatic condenser also made by Messrs. Powell & Lealand, but this was also practically apochromatic. He had not yet had the pleasure of trying it, but he hoped to be able to do so in a very short time.

Mr. T. B. Rosseter's paper "On the Generative Organs of Ostracoda" was read by Prof. Bell.

Prof. Bell said, with regard to the question of motion in the spermatozoa, he did not think that the observations were really out of agreement with Prof. Huxley, who probably meant that there was no active movement. Of course, if there were absolutely no movement, it was tolerably certain that at no distant period the race would become extinct, so that by the expression, "totally deprived of mobility," he supposed was meant that they had not the same activity as that of the flagellate forms.

Mr. Michael thought it was a fact that no motion could be made out in the case of several of the Arthropods. Mr. Campbell said in his paper that he could not detect any motion in the spermatozoa of some of the spiders, and he had himself found the same thing in the case of some of the *Acari*.

Prof. Bell thought that the only cases in which flagellate spermatozoa occurred were in the Scorpions and in *Limulus*.

Prof. Stewart supposed it was rather a *lapsus linguæ* on the part of Prof. Bell when he said the flagellate spermatozoa were rare amongst these classes, because amongst the insects they found them to be all—or

nearly all—flagellate. Again also, as to the remark about the inactivity of the spermatozooids being comparative, he thought the difficulty was hardly so great as imagined. Supposing the fertilizing spermatozoa to be absolutely motionless, he did not see why the race should on that account become extinct, because in this case they had an instance of true copulation, in which these bodies were introduced completely within the passage of the female organ, and it was quite conceivable that by the contraction of its walls they might be eventually brought into contact with the ovum. In the other case mentioned it might be that an amœbiform action was subsequently taken on, because it seemed that a ray or burr-like form was in itself practically unfit to be carried up the duct of the female.

Mr. A. W. Bennett said that in the case of one very large class of plants—the Florideæ—the spermatozoa were entirely devoid of the power of motion.

Prof. Bell pointed out that the amœboid motions in the case of the higher Crustacea had been noticed by a Russian observer.

Mr. W. M. Maskell's paper, "Note on *Micrasterias americana* Ralfs and its varieties," was read by Mr. Crisp (*supra*, p. 7).

Mr. A. W. Bennett said that this paper struck him as being one of very great interest; but to those who had given up the idea of fixity of species it was a matter of arrangement whether they regarded them as different, or as varieties of the same species. The genus *Micrasterias* was one of the most interesting of the Desmidiceæ, because of the comparatively large size and great beauty of many of the forms. The author spoke of the great advantage which would accrue from a monograph of the Desmidiceæ, but he thought if they had a complete monograph of only *Micrasterias* it would be of inestimable value. One of the whole group would be a matter of such enormous labour that it could hardly be hoped for. He could completely corroborate what the author said as to the very great variety of forms which existed in individuals of the same species. He thought this paper was a contribution to science, for which the Society ought to be grateful.

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—*Canthocamptus minutus*.

Mr. Burgess:—*Carterina spiculotesta* Carter, Raine Island, Torres Strait.

Mr. Crisp:—Jaubert's Microscopes (2).

Mr. Guimaraens:—Diatoms from Sysran, Government of Simbirsk, Russia (a new deposit).

Mr. Michael:—Specimen of Mounting Medium in which Ol. Rhodii had been used.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. C. Spence Bate, F.R.S., W. Laurence Gadd, F.C.S., and Rev. Thomas S. King.

MEETING OF 11TH JANUARY, 1888, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (THE REV. DR. DALLINGER, F.R.S.) IN THE CHAIR.

The Minutes of the meeting of 14th December last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
M'Coy, F., Prodromus of the Zoology of Victoria. Decades 1–14. 8vo, Melbourne, 1878–87	*The Government of Victoria.*

The President said that since their last meeting the death had occurred of Dr. Arthur Farre, F.R.S., who was formerly Professor of Obstetrics in King's College and a Physician Extraordinary to the Queen, and who was also one of the first supporters of the Society (elected in 1840) at a time when it held a position very different from that which it occupied at the present day. He was one of those who had actively assisted in bringing microscopy to its present condition of prominence, and his death would be recorded with sorrow.

Mr. Crisp also referred to the death of Mr. Lettsom, formerly a Fellow of the Society, and who was specially interested in the optical questions connected with the Microscope. The death of Mr. Dancer had also taken place, who, although not known to them as an attendant at the meetings, had in former years done much useful work in connection with microscopy.

Mr. Crisp read the list of nominations for Officers and Council for the ensuing year, to be elected at the Annual Meeting in February.

Mr. J. J. Vezey and **Mr. W. W. Reeves** were elected Auditors of the Treasurer's accounts.

Mr. Crisp gave notice, on behalf of the Council, of the alterations in the Bye Laws which it was intended to present to the Annual Meeting for adoption. In consequence of alterations made from time to time in certain of the Bye Laws, the wording of others required revision in order to make them consistent, and some additions had also appeared to be advisable. The nature of the proposed alterations was then explained to the meeting, and the proof of the Bye Laws as amended was laid on the table.

Prof. Stewart exhibited a specimen of a Lamellibranchiate shell which he said possessed some peculiar features of a very interesting character, and which, although often figured, were not generally known to biologists at large. In some of the Mollusca the individuals were monœcious, but in those where the sexes were separate the female shell was usually larger than the male and also differed considerably in shape, as shown by the drawings of each, which he made upon the board. In the genus *Thecalia* the female shell exhibited a peculiarity which was quite unique; this genus contained only two species, of which *con-*

camerata was the one to which the specimen shown belonged. As age advanced the mantle became folded back upon itself in a very curious manner, and simultaneously with this there occurred a similar infolding of the contiguous portions of the shell, by which two depressions were produced, forming a fusiform chamber when the two valves came together. In this cavity the embryonic shells were to be found. In the specimens exhibited this chamber was well seen, although with few exceptions the embryos had been removed.

Edmonds's Automatic Mica Stage, rotating by clockwork, was exhibited and described. It had been devised by Mr. John Edmonds, of Hockley, formerly President of the Birmingham Microscopical Society (*supra*, p. 111).

Mr. Crisp said that, though having by experience become wary as to small-type paragraphs appearing at the bottom of newspaper columns having marvellous headings, but found at the end to be advertisements (such as "A False Swain and a Deluded Spinster," which advocated a hair nostrum), he was taken in by an article which was placed at the head of a column and had attracted his attention by the reference to "The Microscope" and "The many puzzling secrets revealed by this wonderful instrument." On reading it the article was found to be an ingeniously worded advertisement of a wonderful "cure." It was the first time that he had seen the Microscope thus made use of by advertisers as a victim (*supra*, p. 138).

Mr. A. W. Bennett gave a *résumé* of his paper on "Fresh-water Algæ of the English Lake District. II. With descriptions of a new genus and five new species," in continuation of his previous communication on the same subject (*supra*, p. 1).

The President said Mr. Bennett's paper was a most important contribution to their knowledge of a subject which he had made so specially his own. Only one who was a master of this branch of science could recognize the new species in this manner, not only amongst British organisms, but also in the case of foreign forms.

Dr. G. Gulliver read a paper on *Pelomyxa palustris* (*supra*, p. 11).

Prof. Stewart thought that the Fellows were much to be congratulated upon the information which they had received in this paper. The practice of staining in the course of the examination of these lowly organisms had long been employed in rendering the nucleus of the cell more distinct; but, so far as he was aware, this was the first occasion in which, in addition to staining, sections had been made. There were of course many instances in which this could not be done with advantage; but in the case before them, in consequence of the large size of the organism, section-cutting had been possible, and the results had been so encouraging, that he hoped it would be applied in other cases also. If they took a *Pelomyxa* they would see on a front view a large creature very much like an *Amœba*, and also like it, containing masses of granules, which moved forward along those portions of the creature which were extended in the direction in which it intended to move. If they looked at it edgeways, they would see no difference between the endoplasm and the exoplasm, so long as they looked at it in the ordinary way, but if it was stained the granulated structure was at once revealed.

The appearance of the nucleus of the cell would lead to the notion that such cells might perhaps be swarm-spores; careful observation would, however, be necessary to establish this as a fact. As regarded classification, he should not be surprised if it ultimately turned out that these organisms had a nearer relation to the true Heliozoa than to the more lowly *Amœbæ*.

The President expressed the thanks of the meeting to Dr. Gulliver for his paper, and also to Prof. Stewart for his remarks upon the subject. He thought that if one of the tendencies of fifteen or twenty years ago had been to conclude that there was no structure in low organisms of the type of that before them, it was equally certain that the tendency of the present day was to show that there was structure throughout. This was not yet established; but even yet, if it should appear that the endosarc was without structure, it was still certain that the ectosarc was shown to be full of structure.

Mr. E. M. Nelson handed round for inspection two photographic positives, one of *Amphipleura pellucida* and the other of a kind of fungus growth which attacked calcareous sand as described by Mr. J. G. Waller in the 'Journal of the Quekett Microscopical Club' (vol. i. p. 345). This object presented some photographic difficulty because of its non-actinic colour. With regard to the other, he might remark that, in resolving diatoms with oblique light, it was essential to decide whether they intended to focus upon the real surface or upon the optical image produced in a higher plane, in consequence of the double nature of the structure of the valve. In the latter case, they would obtain a result such as he exhibited, which was a photograph of the optical image, and not of the real diatom. He also exhibited the focusing screen for use in the micro-camera which he described at the previous meeting of the Society.

Mr. Nelson also called attention to a curious optical effect, for which at present he was unable to account. In a flat box he had placed a glass positive of *Amphipleura pellucida*, which was viewed as a transparency through a piece of tube fitted at right angles to the surface. If this was looked at when held towards a surface of light, such as an opal lamp-shade or a "sun-light" gas-burner, the black lines appeared to be slightly smaller than the white lines; but if it was turned towards a small light at a distance, then the black lines appeared very large, and the white ones were reduced to mere threads. The scale of the photograph showed that the effect was not due to the operation of the first diffraction spectrum; and it was still more curious to note that in the case of another positive taken from the same negative, and upon the same scale, this optical illusion was not observed.

The following Instruments, Objects, &c., were exhibited:—

Mr. Crisp:—Edmonds's Mica Stage.

Dr. G. Gulliver:—*Pelomyxa palustris.*

Mr. Nelson:—Photomicrographs. Diffraction effect of *Amphipleura pellucida.*

Prof. Stewart:—*Thecalia concamerata.*

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. H. Williams Case, Hahnemann Epps, Thomas W. Kirk, and F. Raymond.

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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One of the Secretaries of the Society

and a Vice-President and Treasurer of the Linnean Society of London;

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FELLOWS OF THE SOCIETY.

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Numerical Aperture. ($n \sin u = a$)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	White Light. ($\lambda = 0{\cdot}5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\ \mu$, Line F.)	Photography. ($\lambda = 0{\cdot}4000\ \mu$, near Line *h*.)		
1·52	..	..	180° 0′	146,543	158,845	193,037	2·310	·658
1·51	..	..	166° 51′	145,579	157,800	191,767	2·280	·662
1·50	..	..	161° 23′	144,615	156,755	190,497	2·250	·667
1·49	..	..	157° 12′	143,651	155,710	189,227	2·220	·671
1·48	..	..	153° 39′	142,687	154,665	187,957	2·190	·676
1·47	..	..	150° 32′	141,723	153,620	186,687	2·161	·680
1·46	..	..	147° 42′	140,759	152,575	185,417	2·132	·685
1·45	..	..	145° 6′	139,795	151,530	184,147	2·103	·690
1·44	..	..	142° 39′	138,830	150,485	182,877	2·074	·694
1·43	..	..	140° 22′	137,866	149,440	181,607	2·045	·699
1·42	..	..	138° 12′	136,902	148,395	180,337	2·016	·704
1·41	..	..	136° 8′	135,938	147,350	179,067	1·988	·709
1·40	..	..	134° 10′	134,974	146,305	177,797	1·960	·714
1·39	..	..	132° 16′	134,010	145,260	176,527	1·932	·719
1·38	..	..	130° 26′	133,046	144,215	175,257	1·904	·725
1·37	..	..	128° 40′	132,082	143,170	173,987	1·877	·739
1·36	..	..	126° 58′	131,118	142,125	172,717	1·850	·735
1·35	..	..	125° 18′	130,154	141,080	171,447	1·823	·746
1·34	..	..	123° 40′	129,189	140,035	170,177	1·796	·741
1·33	..	180° 0′	122° 6′	128,225	138,989	168,907	1·769	·752
1·32	..	165° 56′	120° 33′	127,261	137,944	167,637	1·742	·758
1·31	..	160° 6′	119° 3′	126,297	136,899	166,367	1·716	·763
1·30	..	155° 38′	117° 35′	125,333	135,854	165,097	1·690	·769
1·29	..	151° 50′	116° 8′	124,369	134,809	163,827	1·664	·775
1·28	..	148° 42′	114° 44′	123,405	133,764	162,557	1·638	·781
1·27	..	145° 27′	113° 21′	122,441	132,719	161,287	1·613	·787
1·26	..	142° 39′	111° 59′	121,477	131,674	160,017	1·588	·794
1·25	..	140° 3′	110° 39′	120,513	130,629	158,747	1·563	·800
1·24	..	137° 36′	109° 20′	119,548	129,584	157,477	1·538	·806
1·23	..	135° 17′	108° 2′	118,584	128,539	156,207	1·513	·813
1·22	..	133° 4′	106° 45′	117,620	127,494	154,937	1·488	·820
1·21	..	130° 57′	105° 30′	116,656	126,449	153,668	1·464	·826
1·20	..	128° 55′	104° 15′	115,692	125,404	152,397	1·440	·833
1·19	..	126° 58′	103° 2′	114,728	124,359	151,128	1·416	·840
1·18	..	125° 3′	101° 50′	113,764	123,314	149,857	1·392	·847
1·17	..	123° 13′	100° 38′	112,799	122,269	148,588	1·369	·855
1·16	..	121° 26′	99° 29′	111,835	121,224	147,317	1·346	·862
1·15	..	119° 41′	98° 20′	110,872	120,179	146,048	1·323	·870
1·14	..	118° 0′	97° 11′	109,907	119,134	144,777	1·300	·877
1·13	..	116° 20′	96° 2′	108,943	118,089	143,508	1·277	·885
1·12	..	114° 44′	94° 55′	107,979	117,044	142,237	1·254	·893
1·11	..	113° 9′	93° 47′	107,015	115,999	140,968	1·232	·901
1·10	..	111° 36′	92° 43′	106,051	114,954	139,698	1·210	·909
1·09	..	110° 5′	91° 38′	105,087	113,909	138,428	1·188	·917
1·08	..	108° 36′	90° 34′	104,123	112,864	137,158	1·166	·926
1·07	..	107° 8′	89° 30′	103,159	111,819	135,888	1·145	·935
1·06	..	105° 42′	88° 27′	102,195	110,774	134,618	1·124	·943
1·05	..	104° 16′	87° 24′	101,231	109,729	133,348	1·103	·952
1·04	..	102° 53′	86° 21′	100,266	108,684	132,078	1·082	·962
1·03	..	101° 30′	85° 19′	99,302	107,639	130,808	1·061	·971
1·02	..	100° 10′	84° 18′	98,338	106,593	129,538	1·040	·980
1·01	..	98° 50′	83° 17′	97,374	105,548	128,268	1·020	·990
1·00	180° 0′	97° 31′	82° 17′	96,410	104,503	126,998	1·000	1·000
0·99	163° 48′	96° 12′	81° 17′	95,446	103,458	125,728	·980	1·010
0·98	157° 2′	94° 56′	80° 17′	94,482	102,413	124,458	·960	1·020
0·97	151° 52′	93° 40′	79° 18′	93,518	101,368	123,188	·941	1·031
0·96	147° 29′	92° 24′	78° 20′	92,554	100,323	121,918	·922	1·042
0·95	143° 36′	91° 10′	77° 22′	91,590	99,278	120,648	·903	1·053
0·94	140° 6′	89° 56′	76° 24′	90,625	98,233	119,378	·884	1·064
0·93	136° 52′	88° 44′	75° 27′	89,661	97,188	118,108	·865	1·075
0·92	133° 51′	87° 32′	74° 30′	88,697	96,143	116,838	·846	1 087
0·91	131° 0′	86° 20′	73° 33′	87,733	95,098	115,568	·828	1·099
0·90	128° 19′	85° 10′	72° 36′	86,769	94,053	114,298	·810	1·111
0·89	125° 45′	84° 0′	71° 40′	85,805	93,008	113,028	·792	1·124
0·88	123° 17′	82° 51′	70° 44′	84,841	91,963	111,758	·774	1·136

APERTURE TABLE—*continued.*

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	White Light. ($\lambda = 0{\cdot}5269\,\mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\,\mu$, Line F.)	Photography. ($\lambda = 0{\cdot}4000\,\mu$, near Line *h*.)		
0·87	120° 55′	81° 42′	69° 49′	83,877	90,918	110,488	·757	1·149
0·86	118° 38′	80° 34′	68° 54′	82,913	89,873	109,218	·740	1·163
0·85	116° 25′	79° 37′	68° 0′	81,949	88,828	107,948	·723	1·176
0·84	114° 17′	78° 20′	67° 6′	80,984	87,783	106,678	·706	1·190
0·83	112° 12′	77° 14′	66° 12′	80,020	86,738	105,408	·689	1·205
0·82	110° 10′	76° 8′	65° 18′	79,056	85,693	104,138	·672	1·220
0·81	108° 10′	75° 3′	64° 24′	78,092	84,648	102,868	·656	1·235
0·80	106° 16′	73° 58′	63° 31′	77,128	83,603	101,598	·640	1·250
0·79	104° 22′	72° 53′	62° 38′	76,164	82,558	100,328	·624	1·266
0·78	102° 31′	71° 49′	61° 45′	75,200	81,513	99,058	·608	1·282
0·77	100° 42′	70° 45′	60° 52′	74,236	80,468	97,788	·593	1·299
0·76	98° 56′	69° 42′	60° 0′	73,272	79,423	96,518	·578	1·316
0·75	97° 11′	68° 40′	59° 8′	72,308	78,378	95,248	·563	1·333
0·74	95° 28′	67° 37′	58° 16′	71,343	77,333	93,979	·548	1·351
0·73	93° 46′	66° 34′	57° 24′	70,379	76,288	92,709	·533	1·370
0·72	92° 6′	65° 32′	56° 32′	69,415	75,242	91,439	·518	1·389
0·71	90° 28′	64° 32′	55° 41′	68,451	74,197	90,169	·504	1·408
0·70	88° 51′	63° 31′	54° 50′	67,487	73,152	88,899	·490	1·429
0·69	87° 16′	62° 30′	53° 59′	66,523	72,107	87,629	·476	1·449
0·68	85° 41′	61° 30′	53° 9′	65,559	71,062	86,359	·462	1·471
0·67	84° 8′	60° 30′	52° 18′	64,595	70,017	85,089	·449	1·493
0·66	82° 36′	59° 30′	51° 28′	63,631	68,972	83,819	·436	1·515
0·65	81° 6′	58° 30′	50° 38′	62,667	67,927	82,549	·423	1·538
0·64	79° 36′	57° 31′	49° 48′	61,702	66,882	81,279	·410	1·562
0·63	78° 6′	56° 32′	48° 58′	60,738	65,837	80,009	·397	1·587
0·62	76° 38′	55° 34′	48° 9′	59,774	64,792	78,739	·384	1·613
0·61	75° 10′	54° 36′	47° 19′	58,810	63,747	77,469	·372	1·639
0·60	73° 44′	53° 38′	46° 30′	57,846	62,702	76,199	·360	1·667
0·59	72° 18′	52° 40′	45° 40′	56,881	61,657	74,929	·348	1·695
0·58	70° 54′	51° 42′	44° 51′	55,918	60,612	73,659	·336	1·724
0·57	69° 30′	50° 45′	44° 2′	54,954	59,567	72,389	·325	1·754
0·56	68° 6′	49° 48′	43° 14′	53,990	58,522	71,119	·314	1·786
0·55	66° 44′	49° 51′	42° 25′	53,026	57,477	69,849	·303	1·818
0·54	65° 22′	47° 54′	41° 37′	52,061	56,432	68,579	·292	1·852
0·53	64° 0′	46° 58′	40° 48′	51,097	55,387	67,309	·281	1·887
0·52	62° 40′	46° 2′	40° 0′	50,133	54,342	66,039	·270	1·923
0·51	61° 20′	45° 6′	39° 12′	49,169	53,297	64,769	·260	1·961
0·50	60° 0′	44° 10′	38° 24′	48,205	52,252	63,499	·250	2·000
0·48	57° 22′	42° 18′	36° 49′	46,277	50,162	60,959	·230	2·083
0·46	54° 47′	40° 28′	35° 15′	44,349	48,072	58,419	·212	2·174
0·45	53° 30′	39° 33′	34° 27′	43,385	47,026	57,149	·203	2·222
0·44	52° 13′	38° 38′	33° 40′	42,420	45,981	55,879	·194	2·273
0·42	49° 40′	36° 49′	32° 5′	40,492	43,891	53,339	·176	2·381
0·40	47° 9′	35° 0′	30° 31′	38,564	41,801	50,799	·160	2·500
0·38	44° 40′	33° 12′	28° 57′	36,636	39,711	48,259	·144	2·632
0·36	42° 12′	31° 24′	27° 24′	34,708	37,621	45,719	·130	2·778
0·35	40° 58′	30° 30′	26° 38′	33,744	36,576	44,449	·123	2·857
0·34	39° 44′	29° 37′	25° 51′	32,779	35,531	43,179	·116	2·941
0·32	37° 20′	27° 51′	24° 18′	30,851	33,441	40,639	·102	3·125
0·30	34° 56′	26° 4′	22° 46′	28,923	31,351	38,099	·090	3·333
0·28	32° 32′	24° 18′	21° 14′	26,995	29,261	35,559	·078	3·571
0·26	30° 10′	22° 33′	19° 42′	25,067	27,171	33,019	·068	3·846
0·25	28° 58′	21° 40′	18° 56′	24,103	26,126	31,749	·063	4·000
0·24	27° 46′	20° 48′	18° 10′	23,138	25,081	30,479	·058	4·167
0·22	25° 26′	19° 2′	16° 38′	21,210	22,991	27,940	·048	4·545
0·20	23° 4′	17° 18′	15° 7′	19,282	20,901	25,400	·040	5·000
0·18	20° 44′	15° 34′	13° 36′	17,354	18,811	22,860	·032	5·555
0·16	18° 24′	13° 50′	12° 5′	15,426	16,721	20,320	·026	6·250
0·15	17° 14′	12° 58′	11° 19′	14,462	15,676	19,050	·023	6·667
0·14	16° 5′	12° 6′	10° 34′	13,498	14,630	17,780	·020	7·143
0·12	13° 47′	10° 22′	9° 4′	11,570	12,540	15,240	·014	8·333
0·10	11° 29′	8° 38′	7° 34′	9,641	10,450	12,700	·010	10·000
0·08	9° 11′	6° 54′	6° 3′	7,713	8,360	10,160	·006	12·500
0·06	6° 53′	5° 10′	4° 32′	5,785	6,270	7,620	·004	16·667
0·05	5° 44′	4° 18′	3° 46′	4,821	5,225	6,350	·003	20·000

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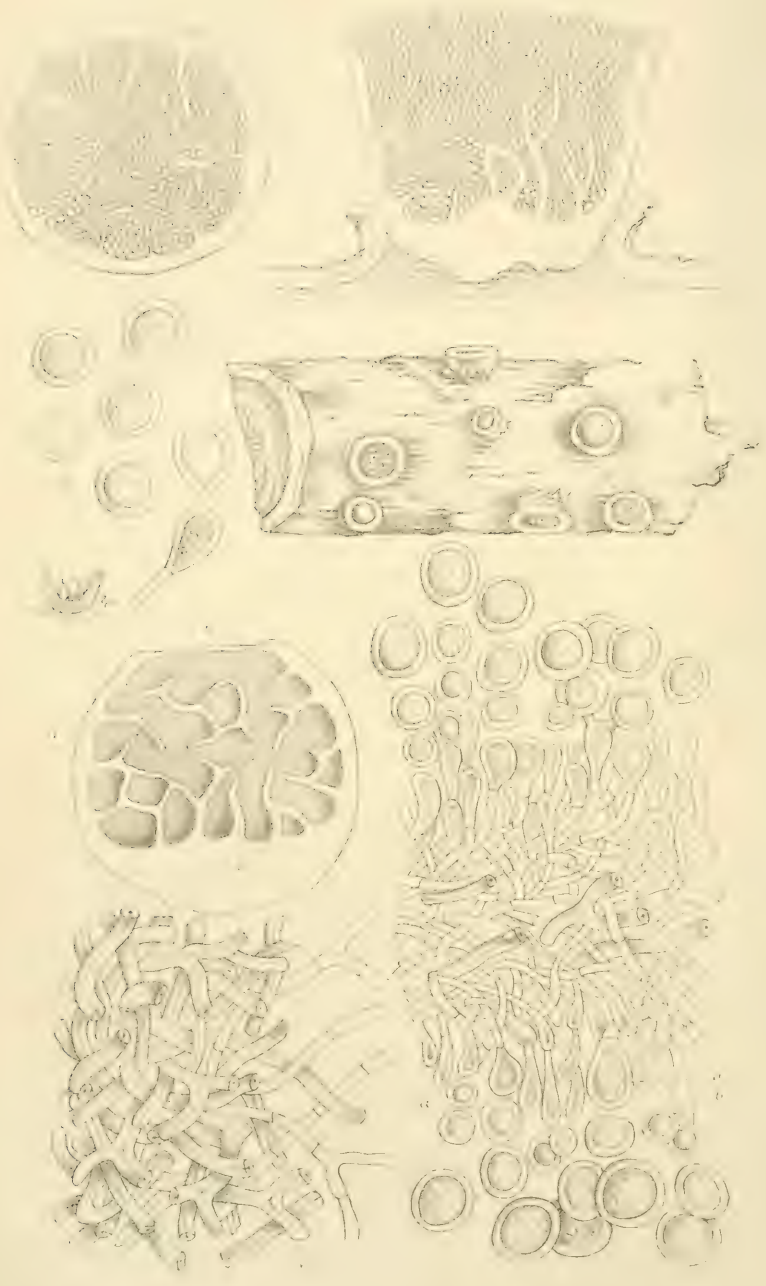


G. Massee del

West, Newman & Co. lith.

Matula poroniæforme, *Mass.*

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL 1888.

TRANSACTIONS OF THE SOCIETY.

IV.—*On the Type of a new order of Fungi.*

By George Massee, F.R.M.S.

(*Read* 14*th March*, 1888.)

Plate IV.

The Rev. M. J. Berkeley and Mr. C. E. Broome, in describing a collection of fungi from Ceylon, established the genus *Artocreas*, characterized as follows:—"Receptaculum commune distinctum; hymenium planum e sporis magnis pulveraceum." * Two species are described—*A. poroniæforme* B. and Br., from Ceylon, which the authors state, in a note following the specific diagnosis, as "looking just like an imperfect *Crucibulum*." The second species, *A. Micheneri* Berk. and Curt., from Cuba and the United States, resembles in general appearance a *Corticium* with a determinate, thickened, raised margin, and agrees with the authors' conceptions as to the affinities of the genus in the order Thelephoreæ, and must henceforth be considered as the type. *A. poroniæforme*, although agreeing with the generic character given above in having a distinct receptacle and plane surface (not hymenium) powdered with large spores, proves on microscopic

EXPLANATION OF PLATE IV.

Fig. 1.—*Matula poroniæforme*; nat. size.
„ 2.—Vertical section of same, showing peridium and septa of gleba, spores removed; nat. size.
„ 3.—Vertical section of young plant, showing peridium, *a*; epiphragm, *b*; and thick septa springing from inner surface of peridium, *c*, × 15 diam.
„ 4.—Vertical section of old plant, showing the thin remains of the septa and mass of spores (the latter drawn larger than their proportion to magnification of section) × 15 diam.
„ 5.—Transverse section of old plant at some distance below the apex, × 15 diam.
„ 6.—Section showing structure of the peridium, × 400 diam.
„ 7.—Section through a septum of a young plant; *a a*, monosporous; *b b*, bisporous basidia, × 400 diam.
„ 8.—Spores, × 400 diam.

* Journ. Linn. Soc. Lond., xiv. p. 73.

examination to have no affinity whatever with the Thelephoreæ, nor even the Hymenomycetes, but with the Gastromycetes, and even here not agreeing with any established order, but combining the salient morphological features of the Hymenogastreæ and Nidularieæ respectively.

The plant grows on dead branches, originating beneath the bark, through which it bursts in the form of a minute ball, that soon expands at the apex, and assumes a cup-like form, more or less cylindrical, or slightly expanded upwards, measuring when full-grown from 4–6 mm. across, and about the same in height. Before bursting through the bark, a vertical section is circular in outline, about 2 mm. diameter, with an irregular base, owing to unequal penetration of the mycelium into the substratum, and consists externally of thick-walled, colourless, aseptate, closely interwoven hyphæ, averaging about 5 μ diameter. At the base of the plant this tissue is more abundant and convex towards the centre, resembling in form the so-called columella in some species of *Lycoperdon*. If the section is exactly median, a minute vertical slit in the outer thick-walled tissue is seen at the apex, which at first suggests the idea of a pore or ostiolum, as in the perithecium of a *Sphæria*, but careful examination shows the slit to be the result of local arrest of the peripheral thick-walled hypha, the innermost portion being alone present, forming the base of what appears at this stage of development as a minute cylindrical depression about 10 μ deep. The central portion consists of compactly interwoven, thin-walled, septate hyphæ, about 3 μ thick, which change towards the periphery into the thick-walled type already described. A few of the latter are also to be seen in the central portion, which at this period exhibits no further differentiation. After breaking through the bark, the plant measures about 4 mm. across, and is yet subglobose and flattened above. The apical slit now appears as a circular depression about 3 mm. across, its floor forming an epiphragm closing the flattened apex, and continuous with the inner portion of the slightly incurved external thick-walled tissue, now differentiated as a peridium.

At this stage of development a vertical section shows a highly differentiated internal structure (fig. 3), which appears to be completed during the period occupied by the plant in bursting through the bark. The external thick-walled tissue now appears as a homogeneous layer about 1 mm. thick, sharply defined internally from the central portion except at certain points, and constitutes the peridium. The central portion or gleba is broken up into numerous irregular loculi by dense septa that are continuous with the inner surface of the peridium at numerous points. The septa contain a few thick-walled hyphæ, but consist mostly of the thin-walled septate type, which run more or less parallel in the central portion, the free ends and numerous lateral branches bending outwards to form the lateral walls, which at first meet in the centre of the loculi, only recognizable at this period by the parallel arrangement of the central components of the septa. In some instances the hypha along the central line of a septum become more or less disorganized at an

early period, but there is no approach to a definite separation into isolated peridiola. All the free tips that clothe the sides of septa appear to become converted into basidia, which are very primitive in structure, being slightly or not at all thickened at the apex, and producing usually a single spore, which at first appears as an obovate terminal cell, attached by a broad base. In rare instances two spores spring from the apex of a clavate basidium. This type of hymenial structure agrees with that of *Hymenogaster decorus*, as figured by Tulasne.* While the spores are still young and obovate, they are set free by the total disappearance of the basidia, afterwards becoming spherical, and increasing considerably in size, measuring when fully developed from 24–28 μ in diameter, including the smooth colourless epispore, from 3–4 μ thick. Succeeding basidia produce spores further and further from the centre of the loculi, which become filled with spores, the septa consequently becoming thinner, until at last nothing remains but the central portion composed of parallel hyphæ, separating loculi densely crowded with spores, which, owing to partial gelification of the thick epispore, become so agglutinated together as to remain attached for some time when a section is placed in water. Contemporaneous with the above changes in the gleba, the upper incurved portion of the peridium becomes erect or very slightly reflexed, and the epiphragm disappears, the mature plant resembling a fully developed *Æcidium* full of spores, but I have not been able to discover in any specimen the notched margin to the peridium as represented in Berkeley's figure.

From the above description it will be seen that the leading features of the plant under consideration are (1) a peridium closed above by an epiphragm until all differentiation is completed; (2) a gleba broken up into numerous cavities or loculi by dissepiments or septa bearing basidia on their free surfaces. The first character conclusively proves the plant to belong to the Gastromycetes; the two combined as conclusively prove that, although not without affinities, it cannot be placed in any hitherto defined order. The presence of a peridium closed by an epiphragm indicates relationship with the Nidularieæ but the gleba possesses a structure unknown in this order, whereas it agrees perfectly with that of the Hymenogastreæ, but in the latter the peridium is indehiscent, and although of minor importance, the species are subterranean. It has been suggested that the indehiscent peridium in the Hymenogastreæ is connected with the subterranean habit, and that a species developing above ground might be expected to have a dehiscent peridium. This idea may be theoretically correct. It is true that subterranean species belonging to all groups are indehiscent, but it is not equally true that allied forms growing above ground are always dehiscent, as should be the case according to the idea given above. *Scleroderma*, *Polysaccum*, &c., are allied, grow above ground, and are indehiscent. Under the circumstances it has been considered advisable to propose the genus *Artocreas* as the type

* Fungi Hypogæi, tab. x. fig. ix. 2.

of a new order, occupying a position exactly intermediate between the Nidulariaceæ and the Hymenogastreæ. I may state that Dr. Cooke concurs with this view.

Matuleæ, nov. ord.

Peridium primum clausum, dein apertum. Gleba multilocularis, dissepimentis crassis, non scissilibus peridioque continuis. Cellulæ vel loculi ad parietes hymeniferæ, basidiis cylindricis vel subclavatis, 1–2 sporis.

Matula Mass. n. gen. Peridium sessile, prima ætate globosum mox cylindricum, regulariter apice dehiscens. Gleba multilocularis, loculis rotundato-irregularibus. Sporæ globosæ.

M. poroniæforme Mass. Erumpens; peridium subcylindricum, ochraceum. Sporæ globosæ, hyalinæ, 24–28 μ diam. *Artocreas poroniæforme* B. & Br. Journ. Linn. Soc. Lond., xiv. p. 73, pl. 2, fig. 5.

Erumpent. Originating below the bark, which is at first raised in a wart-like manner, and eventually ruptured, the plant emerging as a smooth ochraceous ball, which afterwards expands into a cup-like peridium, open at the apex, and crowded with spores at first agglutinated together. The colour of the peridium varies from pale rufous to ochraceous.

On dead branches. Ceylon.

V.—*The President's Address.*

By the Rev. W. H. Dallinger, LL.D., F.R.S., F.L.S., &c.

(*Annual Meeting, 8th February,* 1888.)

Retrospect may involve regret but can scarcely involve anxiety. To one who fully appreciates the actual, and above all, the potential importance of this Society, in its bearing upon the general progress of scientific research in every field of physical inquiry, the responsibilities of President will not be lightly, whilst they may certainly be proudly undertaken.

I think it may be now fairly taken for granted that, as this Society has from the outset promoted and pointed to the higher scientific perfection of the Microscope, so now, more than ever, it is its special function to place this in the forefront as its *raison d'être.* The Microscope has been long enough in the hands of amateur and expert alike, to establish itself as an instrument having an application to every actual and conceivable department of human research; and whilst in the earlier days of this Society it was possible for a zealous Fellow to have seen, and been more or less familiar with, all the applications to which it then had been put, it is different to-day. Specialists in the most diverse areas of research are assiduously applying the instrument to their various subjects, and with results that, if we would estimate aright, we must survey with instructed vision the whole ground which advancing science covers.

From this it is manifest that this Society cannot hope to enfold, or at least to organically bind, to itself, men whose objects of research are so diverse.

But these are all nevertheless linked by one inseverable bond: it is the Microscope; and whilst, amidst the inconceivable diversity of its applications, it remains manifest that this Society has for its primary object the constant progress of the instrument, whether in its mechanical construction or its optical appliances; whether the improvements shall bear upon the use of high powers or low powers; whether it shall be improvement that shall apply to its commercial employment, its easier professional application, or its most exalted scientific use;—so long as this shall be the undoubted aim of the Royal Microscopical Society, its existence may well be the pride of Englishmen, and will commend itself more and more to men of all countries.

This, and this only, can lift a Society of this sort out of what I believe has ceased to be our danger, that of forgetting that in proportion as the optical principles of the Microscope are understood, and the theory of microscopical vision is made plain, the value of the instrument over every region to which it can be applied, and in all the varied hands that use it, is increased without definable limit.

It is therefore by such means that the true interests of science are promoted.

It is one of the most admirable features of this Society that it has become cosmopolitan in its character, in relation to the instrument, and all the ever-improving methods of research employed with it. From meeting to meeting it is not one country or one continent even that is represented on our tables. Nay more; not only are we made familiar with improvements brought from every civilized part of the world, referring alike to the Microscope itself and every instrument devised by specialists for its employment in every department of research, but also, by the admirable persistence of Mr. Crisp and Mr. John Mayall, jun., we are familiarized with every discovery of the old forms of the instrument wherever found or originally employed.

The value of all this cannot be over-estimated, for it will, even where prejudices as to our judgment may exist, gradually make more and more clear that this Society exists to promote and acknowledge improvements in every constituent of the Microscope, come from whatever source they may; and in connection with this, to promote by demonstrations, exhibitions, and monographs the finest applications of the finest instruments for their respective purposes.

To give all this its highest value, of course the theoretical side of our instrument must occupy the attention of the most accomplished experts. We may not despair that our somewhat too practical past in this respect may right itself in our own country; but meantime the splendid work of German students and experts is placed by the wise editors of our Journal within the reach of all.

I know of no higher hope for this important Society than that it may continue in ever increasing strength to promote criticism, and welcome from every quarter of the world whatever will improve the Microscope in itself and in any of its applications, from the most simple to the most complex and important in which its employment is possible.

There are two points of some practical interest to which I desire for a few moments to call your attention. The former has reference to the group of organisms to which I have for so many years directed your attention, viz. the "Monads," which throughout I have called "putrefactive organisms."

There can be no longer any doubt that the destructive process of putrefaction is essentially a process of fermentation.

The fermentative saprophyte is as absolutely essential to the setting up of destructive rotting or putrescence in a putrescible fluid as the torula is to the setting up of alcoholic fermentation in a saccharine fluid. Make the presence of torulæ impossible and you exclude with certainty fermentative action.

In precisely the same way provide a proteinaceous solution, capable of the highest putrescence, but absolutely sterilized, and placed

in an optically pure or absolutely calcined air; while these conditions are maintained, no matter what length of time may be suffered to elapse, the putrescible fluid will remain absolutely without trace of decay; but suffer the slightest infection of the protected and pure air to take place, or, from some putrescent source, inoculate your sterilized fluid with the minutest atom, and shortly turbidity, offensive scent, and destructive putrescence ensue.

As in the alcoholic, lactic, or butyric ferments, the process set up is shown to be dependent upon and concurrent with the vegetative processes of the demonstrated organisms characterizing these ferments, so it can be shown with equal clearness and certainty that the entire process of what is known as putrescence is equally and as absolutely dependent on the vital processes of a given and discoverable series of organisms.

Now it is quite customary to treat the fermentative agency in putrefaction as if it were wholly bacterial; and indeed the putrefactive group of bacteria are now known as saprophytes, or saprophytic bacteria, as distinct from morphologically similar, but physiologically dissimilar forms known as parasitic or pathogenic bacteria.

It is indeed usually, and justly admitted, that *B. termo* is the exciting cause of fermentative putrefaction. Cohn has, in fact, contended that this is the distinctive ferment of all putrefactions, and that it is to decomposing proteinaceous solutions what *Torula cerevisiæ* is to the fermenting fluids containing sugar.

In a sense this is no doubt strictly true. It is impossible to find a decomposing proteinaceous *solution* at any stage without finding this form in vast abundance.

But it is well to remember that in nature putrefactive ferments must go on to an extent rarely imitated or followed in the laboratory. As a rule the pabulum in which the saprophytic organisms are provided and "cultured" is infusions, or extracts of meat carefully filtered; and if vegetable matter is used, extracts of fruit, treated with equal care, and if needful neutralized, are used in a similar way. To these may be added all the forms of gelatin, employed in films, masses, and so forth.

But in following the process of destructive fermentation, as it takes place in large masses of tissue, animal or vegetable, but far preferably the former, as they lie in water at a constant temperature of from 60° to 65° F., it will be seen that the fermentative process is the work, not of one organism, nor, judging by the standard of our present knowledge, of one specified class of vegetative forms, but by organisms which, though related to each other, are in many respects greatly dissimilar, not only morphologically, but also embryologically and even physiologically.

Moreover, although this is a matter that will want most thorough and efficient inquiry and research to understand properly its conditions, yet it is sufficiently manifest that these organisms succeed each other in a curious and even remarkable manner. Each does a part

in the work of fermentative destruction, each aids in splitting up into lower and lower compounds the elements of which the masses of degrading tissue are composed; while apparently, each set in turn does, by vital action coupled with excretion, (1) take up the substances necessary for its own growth and multiplication; (2) carry on the fermentative process; and (3) so change the immediate pabulum as to give rise to conditions suitable for its immediate successor. Now the point of special interest is that there is an apparent adaptation in the form, functions, mode of multiplication, and order of succession in these fermentative organisms which is deserving of study and fraught with instruction.

Let it be remembered that the aim of nature in this fermentative action is not the partial splitting of certain organic compounds and their reconstruction in simpler conditions; but the ultimate setting free by saprophytic action of the elements locked up in great masses of organic tissue—the sending back into nature of the only material of which future organic structures are to be composed.

I have said that there can be no question whatever that *Bacterium termo* is the pioneer of saprophytes: exclude *B. termo* (and therefore with it all its congeners), and you can obtain no putrefaction. But, wherever in ordinary circumstances a decomposable organic mass, say the body of a fish, or a considerable mass of the flesh of a terrestrial animal, is exposed in water at a temperature of 60° to 65° F. *B. termo* rapidly appears, and increases with a simply astounding rapidity. It clothes the tissues like a skin, and diffuses itself throughout the fluid.

The exact chemical changes it thus effects are not at present clearly known, but the fermentative action is manifestly concurrent with its multiplication. It finds its pabulum in the mass it ferments by its vegetative processes. But it also produces a visible change in the enveloping fluid, and noxious gases continuously are thrown off.

In the course of a week or more, dependent on the period of the year, there is—not inevitably, but as a rule—a rapid accession of spiral forms, such as *Spirillum volutans*, *S. Undula*, and similar forms, often accompanied by *Bacterium lineola*, and the whole interspersed still with inconceivable multitudes of *B. termo*.

These invest the rotting tissues like an elastic garment, but are always in a state of movement. These again manifestly further the destructive ferment, and bring about a softness and flaccidity in the decomposing tissues, while they without doubt, at the same time have, by their vital activity and possible secretions, affected the condition of the changing organic mass. There can be, so far as my observations go, no certainty as to when, after this, another form of organism will present itself; nor when it does, which of a limited series it will be. But in a majority of observed cases, a loosening of the living investment of bacterial forms takes place, and simultaneously with this, the access of one of two forms of my putrefactive monads. They were amongst the first we worked at; and have

been, by means of recent lenses, amongst the last revised. Mr. S. Kent named them *Cercomonas typica*, and *Monas Dallingeri* respectively. They are both simple oval forms; but the former has a flagellum at both ends of the longer axis of the body, while the latter has a single flagellum in front.

Their principal difference is in their mode of multiplication by fission and in the genetic method of germ production. The former is in every way like a Bacterium in its mode of self-division. It divides, acquiring for each half a flagellum in division, and then, in its highest vigour, in about four minutes, each half divides again.

The second form does not divide into two, but into many; and thus, although the whole process is slower, it developes with greater rapidity. But both ultimately multiply, that is, commence new generations by the equivalent of a sexual process.

These would average about four times the size of *Bacterium termo;* and when once they gain a place on and about the putrefying tissues, their relatively powerful and incessant action, their enormous multitude, and the manner in which they glide over, under, and beside each other as they invest the fermenting mass, is worthy of close study. It has been the life-history of these organisms, and not their relations as ferments, that has specially occupied my fullest attention; but it would be in a high degree interesting if we could discover or determine what, besides the vegetative or organic processes of nutrition, is being effected by one or both of these organisms on the fast-yielding mass. Still more would it be of interest to discover what, if any, changes were wrought in the pabulum or fluid generally; for after some extended observations I have found that it is only after one or other, or both of these organisms have performed their part in the destructive ferment that subsequent and extremely interesting changes arise.

It is true that in some three or four instances of this saprophytic destruction of organic tissues, I have observed that, after the strong bacterial investment, there has arisen, not the two forms just named, nor either of them, but one or other of the striking forms now called *Tetramitus rostratus* and *Polytoma uvella;* but this has been in relatively few instances. The rule is, that *Cercomonas typica* or its congener precede other forms that not only succeed them in promoting and carrying to a still further point the putrescence of the fermenting substratum, but appear to be aided in the accomplishment of this by mechanical means.

By this time the mass of tissue has ceased to cohere. The mass has largely disintegrated, and there appears amongst the countless bacterial and monad forms some one, and sometimes even three forms, that, whilst they at first swim and gyrate, and glide about the decomposing matter, which is now much less closely invested by *Cercomonas typica*, or those organisms that may have acted in its place, they also resort to an entirely new mode of movement.

One of these forms is *Heteromita rostrata*, which, it will be

remembered, in addition to a front flagellum, has also a long fibre or flagellum-like appendage that gracefully trails as it swims. At certain periods of their life these forms anchor themselves in countless billions all over the fermenting tissues, and, as I have described in the life-history of this form,* they coil their anchored fibre as does a vorticellan, bringing the body to the level of the point of anchorage, then shoot out the body with lightning-like rapidity, and bring it down like a hammer on some point of the decomposition. It rests here for a second or two and repeats the process; and this is taking place by what seems almost like rhythmic movement all over the rotting tissue. The results are scarcely visible in the mass; but if a group of these organisms be watched, attached to a small particle of the fermenting tissue, it will be seen to gradually diminish, and at length to disappear.

Now there are at least two other similar forms, one of which, *Heteromita uncinata*, is similar in action, and the other of which, *Dallingeria Drysdali*, is much more powerful, being possessed of a double anchor, and springing down upon the decadent mass with relatively far greater power.

Now it is under the action of these last forms, that in a period, varying from one month to two or three, the entire substance of the organic tissues disappears, and the decomposition has been designated by me "exhausted"; nothing being left in the vessel but slightly noxious and pale grey water, charged with carbonic acid, and a fine buff-coloured impalpable sediment at the bottom.

My purpose is not, by this brief notice, to give an exhaustive, or even a sufficient account of the progress of fermentative action, by means of saprophytic organisms, on great masses of tissue; my observations have been incidental, but they lead me to the conclusion that the fermentative process is not only not carried through by what are called Saprophytic Bacteria, but that a *series* of fermentative organisms arise, which succeed each other, the earlier one preparing the pabulum or altering the surrounding medium, so as to render it highly favourable to a succeeding form. On the other hand, the succeeding form has a special adaptation for carrying on the fermentative destruction more efficiently, from the period at which it arises, and thus ultimately of setting free the chemical elements locked up in dead organic compounds.

That these later organisms are saprophytic, although not bacterial, there can be no doubt. A set of experiments recorded by me in the 'Proceedings' of this Society some years since, would go far to establish this.† But it may be readily shown, by extremely simple experiments, that these forms will set up fermentative decomposition rapidly, if introduced in either a desiccated or living condition, or in the spore state, into suitable but sterilized pabulum.

Thus, while we have specific ferments which bring about definite

* Mon. Micr. Journ., xi. (1874) pp. 7 *et seq.*
† Ibid., xvi. (1876) p. 288.

and specific results; and while even infusions of proteid substances may be exhaustively fermented by saprophytic Bacteria, the most important of all ferments — that by which nature's dead organic masses are removed—is one which is brought about by the successive vital activities of a series of adapted organisms, which are for ever at work in every region of the earth.

There is one other matter of some interest and moment on which I would say a few words. To thoroughly instructed biologists such words will be quite needless: but in a Society of this kind, the possibilities that lie in the use of the instrument are associated with the contingency of large error, especially in the biology of the minuter forms of life, unless a well-grounded biological knowledge form the basis of all specific inference, to say nothing of deduction.

I am the more encouraged to speak of the difficulty to which I refer, because I have reason to know that it presents itself again and again in the provincial Societies of the country, and is often adhered to with a tenacity worthy of a better cause. I refer to the danger that always exists, that young or occasional observers are exposed to, amidst the complexities of minute animal and vegetable life, of concluding that they have come upon absolute evidences of the transformation of one minute form into another; that, in fact, they have demonstrated cases of Heterogenesis.

This difficulty is not diminished by the fact that, on the shelves of most Microscopical Societies there is to be found some sort of literature written in support of this strange doctrine.

You will pardon me for allusion to the field of inquiry in which I have spent so many happy hours. It is, as you know, a region of life in which we touch, as it were, the very margin of living things. If nature were capricious anywhere, we might expect to find her so here; if her methods were in a slovenly or only half-determined condition, we might expect to find it here. But it is not so. Know accurately what you are doing; use the precautions absolutely essential, and through years of the closest observation it will be seen that the vegetative and vital processes generally, of the very simplest and lowliest life-forms, are as much directed and controlled by immutable laws as the most complex and elevated.

The life-cycles, accurately known, of monads, repeat themselves as accurately as those of Rotifers or Planarians.

And, of course, on the very surface of the matter the question presents itself to the biologist why it should not be so. The irrefragable philosophy of modern biology is that the most complex forms of living creatures have derived their splendid complexity and adaptations from the slow and majestically progressive variation and survival from the simpler and the simplest forms. If, then, the simplest forms of the present and the past were not governed by accurate and unchanging laws of life, how did the rigid certainties that manifestly and admittedly govern the more complex and the most complex come into play?

If our modern philosophy of biology be, as we know it is, true, then it must be very strong evidence indeed that would lead us to conclude that the laws seen to be universal break down and cease accurately to operate, where the objects become microscopic, and our knowledge of them is by no means full, exhaustive, and clear.

Moreover, looked at in the abstract, it is a little difficult to conceive why there should be more uncertainty about the life-processes of a group of lowly living things, than there should be about the behaviour, in reaction, of a given group of molecules.

The triumph of modern knowledge is a knowledge—which nothing can shake—that nature's processes are immutable. The stability of her processes, the precision of her action, and the universality of her laws, are the basis of all science, to which biology forms no exception. Once establish, by clear and unmistakable demonstration, the life-history of an organism, and truly some change must have come over nature as a whole, if that life-history be not the same to-morrow as to-day; and the same to one observer, in the same conditions, as to another.

No amount of paradox would induce us to believe that the combining proportions of hydrogen and oxygen had altered in a specified experimenter's hands in synthetically producing water.

We believe that the melting-point of platinum and the freezing point of mercury are the same as they were a hundred years ago, and as they will be a hundred years hence.

Now carefully remember that, so far as we can see at all, it must be so with life. Life inheres in protoplasm; but just as you cannot get *abstract matter*—that is, matter with no properties or modes of motion—so you cannot get *abstract* protoplasm. Every piece of living protoplasm we see has a history: it is the inheritor of countless millions of years. Its properties have been determined by its history. It is the protoplasm of some definite form of life which has inherited its specific history. It can be no more false to that inheritance than an atom of oxygen can be false to its properties.

All this, of course, within the lines of the great secular processes of the Darwinian laws, which, by the way, could not operate at all if caprice formed any part of the activities of nature.

But let me give a practical instance of how what appears like fact may override philosophy, if an incident, or even a group of incidents, *per se*, are to control our judgment.

Eighteen years ago I was paying much attention to Vorticellæ. I was observing with some pertinacity *Vorticella convallaria*—for one of the calices was in a strange and semi-encysted state, while the remainder were in full normal activity. I watched with great interest and care, and have in my folio still the drawings made at the time. The stalk carrying this individual calyx fell upon the branch of vegetable matter to which the Vorticellan was attached, and the calyx became perfectly globular, and at length there emerged from it a small form, with which in this condition I was quite unfamiliar. It

was small, tortoise-like in form, and crept over the branch on setæ or hair-like pedicles; but carefully followed, I found it soon swam, and at length got the long neck-like appendage of *Amphileptus anser!*

Here, then, was the cup or calyx of a definite Vorticellan form changing into (?) an absolutely different Infusorian, viz. *Amphileptus anser!*

Now, I simply reported the fact to the Liverpool Microscopical Society, with no attempt at inference; but two years after I was able to explain the mystery, for, finding in the same pond both *V. convallaria* and *A. anser*, I carefully watched their movements, and saw the *Amphileptus* seize and struggle with a calyx of Convallaria, and absolutely become encysted upon it, with the results that I had reported two years before.

And there can be no doubt but this is the key to the cases that come to us again and again, of minute forms suddenly changing into forms wholly unlike. It is happily amongst the virtues of the man of science to "rejoice in the truth," even though it be found at his expense; and true workers, earnest seekers for nature's methods, in the obscurest fields of her action, will not murmur that this source of danger to younger microscopists has been pointed out, or recalled to them.

And now I bid you, as your President, farewell. It has been all pleasure to me to serve you. It has enlarged my friendships and my interests; and, although my work has linked me with the Society for many years, I have derived much profit from this more organic union with it; and it is a source of encouragement to me, and will, I am sure, be to you, that, after having done with simple pleasure what I could, I am to be succeeded in this place of honour by so distinguished a student of the phenomena of minute life as Dr. Hudson. I can but wish him as happy a tenure of office as mine has been.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Polar Globule of Mammalian Ovum.‡—Prof. G. Bellonci describes the formation of a polar globule in the ovarian ova of several mammals —mole, guinea-pig, and rabbit. His best results were obtained from the two former. What he observed in the rabbit ovum was less satisfactory. He notes and figures the position of the germinal vesicle at the animal pole, the transformation of the nucleus, the spindle, the equatorial aggregation, in one good instance the formation of two well-formed "coronæ," and the actual separation. In the formed polar globule he was never able to demonstrate a morphologically complete nucleus. He discusses the question of the really cellular nature of these extruded elements, and compares what he has observed in mammals with other cases of karyokinesis. In an appended paper he discusses certain curious phenomena of segmentation in the ovarian ova of mole and rabbit, which suggest the beginning of parthenogenesis, but are more probably interpreted as phenomena of degeneration.

Vestiges of Zonary Decidua in Mouse.§—Mr. J. A. Ryder, with the assistance of Mr. G. Fetterolf, has investigated the decidua of the mouse. The mucosa thickens very much around the embryo, forming a ring of tissue around the blastodermic vesicle. Of this, only that portion persists which lies near where the discoidal placenta is subsequently formed. On the side opposite the placenta, and at the sides of the blastodermic vesicle, the ring is absorbed. "The hoop-like thickening which is continued from opposite sides of the placental region, and which encircles the fœtus and its membranes, is nothing more or less than the transitory representative of a zonary or girdle-like decidua." The hypertrophied portion or annular band of the mucosa is absorbed

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called but also those dealing with Evolution, Development, and Reproduction, and allied subjects. ‡ Mem. Accad. Sci. Bologna, vi. (1886) pp. 363-5, 367-9 (1 pl.).

§ Amer. Natural., xxi. (1887) pp. 1037-8.

by huge cytoclasts or phagocytes. They are unusually large, and have very large nuclei. The presence of abortive villi on the surface of the chorion in the vicinity of the hint of a girdle is a further proof of its suggested presence. The data seem to show that the primitive type of placentation was more diffuse than in existing myomorph rodents, and throw light on the derivation of discoidal from zonary placentation.

Development of Blood-vascular System of the Chick.*—Dr. N. Uskow is of opinion that the hen's egg is, in the true sense of the word, a giant-cell. Its protoplasm is ordinarily so thickly impregnated with the fine elements of the white yolk that its presence is only detectable on the appearance of nuclei; the elements of the yellow yolk are at first apparently much more closely connected with the protoplasm; in later stages of development the protoplasm may be seen even though there are no nuclei; but the presence of the latter may serve as a proof of the protoplasmic nature of the visible network. All the changes in the egg during the development of the embryo may be regarded as the gradual agglomeration of the protoplasm towards the periphery, and as its segmentation with formation of numerous nuclei, and later, cells. These two processes succeed one another, and begin at the upper end of the vertical axis of the egg. The process of segmentation does not go on uninterruptedly, for there are some breaks after the appearance of cells in the peripheral portions.

The hypoblast is differently formed in different regions, and may be conveniently divided into three parts:—(1) Marginal portion of the hypoblast, where the protoplasm contains nuclei, and has no signs of cell-formation, save a feeble indication of this process in the upper layers; (2) Intermediate portion, with cylindrical, not fully developed cells; and (3) Central part, with distinct epithelial cells. It is to the first two of these portions that the blood-vascular system owes its origin, while the marginal portion also gives rise to the peripheral part of the mesoblast. To explain their origin it is not necessary to make use of the hypothesis of the emigration of cells through the yolk; all the observed phenomena may be explained by supposing the elements to arise at the place where they are found.

Remak's cord is only one of the stages of a common form of development of the vascular system, and is not the only one or the most primitive; the vessels and blood are developed below the mesoblast, and are only later surrounded by it. The blood is not formed before the vessels, or the vessels before the blood; "as one process conditions the appearance of the other, the two are simultaneous." The vascular lumen is neither an intracellular nor an intercellular space. There is no ground for regarding the first vessels which appear in the central part of the zona pellucida and in the embryo as secondary. Some of the vessels appear in the course of development as vesicles.

The author concludes that the formation of the blood and the vessels of a chick may be taken as a distinct support of the view that the living protoplasm of a fertilized ovum contains in different parts various definite tissues of the organism from which it is derived.

Development of Emu.†—Mr. W. A. Haswell gives an account of his observations on the early stages in the development of the emu,

* Mém. Acad. Imp. St.-Pétersbourg, xxxv. (1887) 48 pp. (2 pls.).
† Proc. Linn. Soc. N. S. Wales, i. (1887) pp. 577–600 (8 pls.).

which are of interest not only in themselves, but as the first recorded researches on the embryology of any member of the Ratitæ. The period of incubation in the emu is three months, and the time between the developmental events is therefore great when compared with the development, for instance, of the chick. An average egg weighs 21 ounces; and measures 4 inches by 3½ inches. About forty are laid in a summer; the male incubates the first set and is then succeeded by the female who has by that time finished her laying.

The first blastoderm studied was one of 51 hours, and measured a centimetre in breadth. The area pellucida, which measured 3 mm. in maximum diameter, presented two regions—an anterior, rounded and rather broader than long, and a posterior bay, the commencement of the primitive streak region. There was no trace of a primitive groove. Sections showed two completed layers, separate in the anterior region, confluent in the primitive streak. In front of the anterior end of the primitive streak, the lower layer presents a slight thickening, the rudiment of the "head-process." Flattened cells in the lower layer of the head-process are the first hints of the final hypoblast. There was no appearance of the "sickle" seen in the chick and other forms.

In a blastoderm of 70 hours, the area pellucida has a shape very unlike the corresponding stage in the fowl. The anterior part is circular, the posterior a long narrow prolongation, bearing the primitive streak which runs towards the centre of the rounded part, and exhibits a well-developed primitive groove. In the anterior part the hypoblast is not yet definite, the epiblast many-layered in the middle, the mesoblast has not yet reached this region. The head-process is larger; the primitive streak has the usual axial plate continuous with the surface epiblast; its lateral wings extend outwards between the epiblast and here continuous hypoblast of flattened cells; the mesoblast extends outwards far beyond the termination of the hypoblast in the germinal wall. In the hinder part of the streak, below the groove, there seems to be an imperfectly united suture in the axial plate. The hypoblast below this is continuous, but in the centre below the suture the ordinary cells are replaced by a large coarsely granular cell. Here there is indication of the lips of the anterior part of the blastopore. Below the blastoderm are large, round, granular, formative cells of Balfour, probably nutritive in function.

In a specimen incubated for 66 hours, the posterior prolongation was broader and less marked, the head-process more definite, a semicircular groove marked the position of the anterior boundary of the future medullary plate, the suture in the streak has disappeared.

From these stages it was evident that the primitive streak cannot grow forwards from the posterior border of the area pellucida, as generally described; but is formed from before backwards, simultaneously with an extension backwards in the form of a narrow bay of the area pellucida.

The head-process is merely the continuation forwards for a short distance of the axial thickening of the lower layer which accompanies the formation of the primitive streak.

The history of the mesoblast in the emu is summarized; its foundation is laid by the cells of the lower layer, and no part up to the stage reached above is formed directly from epiblast.

Subsequent stages are more briefly described; the appearance of

medullary groove, of notochord apparently from mesoblast, of proto-vertebræ, &c., are described. In regard to the notochord and the destiny of the primitive streak, Haswell substantially agrees with Kölliker. In describing later stages, the appearance of the neurenteric canal is specially noticed.

Fate of the Blastopore in Amphibians.*—Dr. F. Schanz finds that in *Triton tæniatus* and *Rana temporaria* the blastopore becomes narrowed by the approximation of the lateral lips of the orifice. In *Triton* two orifices appear, one of which becomes the neurenteric canal and the other the anus. In the frog there is only one orifice, the place of the other being taken by a pit, which, later on, opens into the rectum; the cause of this is the rapid growth of the medullary folds, and the anus is not a neomorph. The oblique direction seen in the frog is due to the growth of the tail; the neurenteric canal really exists even if it has no distinct lumen, such as is later seen in the frog. These results are by no means in agreement with those lately arrived at by Prof. Kupffer.

Spermatogenesis of Salamander.† — Prof. W. Flemming has re-directed his attention to the spermatogenesis of *Salamandra maculata*, which he first investigated in 1880. His chief results are as follows:—(1) The head of the sperm of Urodela is formed from the entire chromatin of the spermatide nucleus. (2) The formation of the stainable head-process is associated with gradual thickening and elongation of the nuclear network. (3) Young forms freed from their natural surroundings contract in a curious fashion. (4) One end of the spermatide nucleus is from the first thicker in its elongation, and forms the posterior (tail) end of the head. (5) The rudiment of the achromatic middle portion is at first to some extent chromatic, and therefore nuclear. (6) The tail filament can at first be traced through the centre of the middle portion to the base of the head. It is also probably from the nucleus. (7) In their stage of elongation the spermatides include nucleoli, but these appear to have no morphological *rôle*. (8) The spermatogenesis progresses in a testicular lobe from one end to the other. (9) Before the beginning of spermatogenesis, the spermatocyst is seen to include a cavity which moves to the foot of the cyst. Round this the spermatide nuclei or cells become regularly disposed. (10) The space includes chromatophilous granules, which persist between the heads of the spermatides. (11) The heads of the perfectly mature sperms are distinguishable by the peculiar brown colour assumed on staining with safranin. (12) Wiedersperg's conclusions rest on misinterpretation.

Germinal Layers in Teleostei.‡—Mr. G. Brook gives an account of the structure of the ripe unfertilized ovum of the herring, of the early stages in development, and particularly of the relation of the parablast (subgerminal free nucleated layer) to the yolk and to the embryo. In describing the structure of the ripe ovum not much that is new is recorded; the author unites the descriptions of Kupffer and Hoffmann, and corroborates both in reconciling them. The ovum is an ideal meso-blastic type. Before the first furrow appears the egg is made up as follows:—(1) Of a large collection of protoplasm in the germinal area

* Jenaisch. Zeitschr. f. Naturwiss., xxi. (1887) pp. 411–21 (1 pl.).
† Arch. f. Mikr. Anat., xxxi. (1887) pp. 71–97 (1 pl.).
‡ Trans. Roy. Soc. Edin., xxxiii. (1887) pp. 199–239 (3 pls.).

in which segmentation generally commences; (2) of a thin film of cortical protoplasm entirely surrounding the yolk, and frequently presenting a considerable dilatation at the yolk-pole; (3) of a number of filamentous protoplasmic processes, mainly confined to the base of the germinal area, which serve to keep up a communication between the latter and the more purely nutritive yolk; (4) of the nutritive yolk itself, which constitutes the greater portion of the ovum.

Segmentation.—No nucleus was observed until after the third furrow was formed. The first furrow which takes an equatorial direction is the third of the series. There is a period of quiescence between the completion of one furrow and the commencement of the next. On the formation of the third furrow there are two distinct layers, of archiblast which goes on segmenting, and of parablast which remains as a connecting area between the latter and the yolk. The mesoblastic segmentation is compared with the holoblastic division of the frog ovum, and the nutritive physiology of the embryo at this stage is discussed.

Parablast.—Mr. Brook gives an historical *résumé* of the various opinions held in regard to the origin and relations of the parablast. He then communicates his own observation. At the end of the primary segmentation-stage in the herring, the parablast, which has increased considerably at the expense of the yolk, leaves the periphery, and collects mainly under the archiblast. The archiblast becomes differentiated into two layers. The outer and somewhat flattened cells form the epidermal layer of epiblast. The cells more centrally situated are larger, more rounded, less deeply stainable, loosely aggregated, and represent the nervous layer of the epiblast. Beneath the archiblast, the parablast appears as a thick layer of protoplasm undergoing division into cells. No karyokinesis was seen. Brook regards the cells thus formed as secondary segmentation products in the sense of Waldeyer. They join those derived from primary segmentation in the archiblast, and soon become undistinguishable from them. In eggs forty-five hours after fertilization the subgerminal parablast is only a very thin film. The peripheral parablast, however, is a thick wedge-shaped mass, stretching from the base of the morula to the equator of the egg, and containing a considerable number of rows of nuclei. All this is before the extension of the morula over the yolk, before the formation of the segmentation-cavity, and before the differentiation of the germinal layers. In most Teleostean ova the morula is solely archiblastic, and it is only later that parablastic elements are utilized; but here, at least, two distinct batches of parablast-cells are budded off and unite with those of the archiblast before any trace of differentiation of the morula. The final morula is parablastic as well as archiblastic. The difference is important, and probably connected with the early elaboration of the parablast, and probably also with the absence of a vitelline circulation. When the segmentation-cavity appears, the parablast forms its floor, the cells of the morula its roof and sides. The thickening which forms the commencement of the blastodermic rim may be in part due to the addition or segregation of cells from the parablast. The parablast certainly extends under the thickened peripheral portion of the blastoderm, and around its margin forms a thickened welt. At a later stage it is distinctly evident that the primitive hypoblast is mainly, if not entirely, formed from the parablast. Mr. Brook defends this conclusion against objections. Some later embryonic stages are briefly alluded to.

"In the Teleostean ovum the protoplasm in the vegetative pole increases rapidly in bulk by an assimilation of its inclosed food-material, and is thus enabled to bud off cells, which, had the distribution of yolk and protoplasm been otherwise, would have been produced by normal segmentation. Thus arises the distinction between primary and secondary segmentation. The separation of animal from vegetative pole in the herring comes with the formation of the third furrow. The archiblast in the herring, together with the cells derived from the parablast, prior to the formation of the segmentation-cavity, give rise to the epiblast. The vegetative pole then gives rise to the primitive hypoblast, which is in turn differentiated into the mesoblast and permanent hypoblast. The primitive hypoblast, as observed in the herring, is precisely homologous with that of *Amphioxus*. In both it becomes differentiated into two lateral plates of mesoblast separated by the notochord, and what remains constitutes the permanent hypoblast."

Segmentation of Teleostean Ova.*—Sig. R. Fusari has studied the segmentation of the ova of *Cristiceps argentatus*. (1) The first line of division is across the smaller diameter of the germinal area, and slightly eccentric. It is probably transverse to the future embryo. (2) The second is meridional, at right angles to the first; and the third and fourth lines of segmentation, though irregular, are meridional. (3) Two meridional segmentations are often seen interposed between the first two. The blastoderm from above exhibits eight triangular cells with convex peripheral bases. (4) In the next stage twelve blastomeres are seen like petals round a central region including four. All the elements are united solely by their bases. (5) The blastoderm appears as an ellipsoidal disc of sixteen peripheral blastomeres, covering other sixteen interior elements. Comparing the phenomena with those of sturgeon ova, Fusari collates (1) the internal blastomeres and the micromeres; (2) the external blastomeres and the macromeres; (3) the free central covered-in space and the segmentation-cavity. (6) The blastoderm becomes a double layer. (7) The peripheral cells share in this less rapidly than the central elements. In successive stages it is seen that certain blastomeres detach themselves from the peripheral zone and join the central disc. At a certain stage the blastoderm consists of an ellipsoidal disc of cells, and of a delicate nucleated plasmodial zone of protoplasm. As the segmentation goes on, the nuclei of the plasmodium multiply, first by karyokinesis, afterwards by simple constriction. Thus is formed the perivitelline membrane, periblast, or parablast. The blastoderm at the end of segmentation is equivalent to all the epiblast and a portion of the hypoblast in the sturgeon. The perivitelline membrane corresponds to the persisting portion of the primitive hypoblast, is a temporary nutritive organ for the blastoderm, and supplies new elements (for blood, &c.) to the embryo.

Eggs and Larvæ of Teleosteans.†—Mr. J. T. Cunningham having previously described and figured the eggs, embryo, and larvæ of a large number of Teleosteans, with diagnoses and drawings referring to fifteen species, now gives, in the second portion of his memoir, an account of what is at present known in regard to the eggs and larvæ of the several orders, and furnishes a useful summary of scattered data. The third

* Arch. Ital. Biol., ix. (1887) pp. 22–4.

† Trans. Roy. Soc. Edin xxxiii. (1887) pp. 97–136 (7 pls.).

portion of the memoir raises two questions in regard to the maturation and fertilization of the ovum, viz. (1) Is it possible to trace the transformations of the nucleus which accompany the expulsion of the polar bodies? and (2) Is there any foundation for Hoffmann's statement that the first segmentation spindle is directed radially, and divides into a superficial nucleus which belongs to the archiblast, and a deeper one which belongs to the periblast. In regard to the first question, Mr. Cunningham observed in the ova of *Pleuronectes cynoglossus* the expulsion of a polar body, and what might be hints of a second, but no nuclear spindle. In regard to the second question, the author suggests that Hoffmann has been misled by the relative positions in which the two segmentation nuclei are seen when the ovum is in a certain position (illustrated in a diagram) with respect to the axis of the Microscope.

Origin of Blood in Teleostei.* — Dr. H. E. Ziegler adds another research to the number which have been lately devoted to the origin of the blood-corpuscles in bony fishes. It has been shown by various observers that the blood-corpuscles arise not from the yolk, but from mesodermic elements. Herr Ziegler has reinvestigated the subject at Naples.

I. *The periblast and the germinal layers.* In the Teleostei at the time when the blood-corpuscles arise, there are in the yolk no defined cells, but only "free" nuclei. Morphologically, these nuclei correspond to the nuclei of the yolk-cells in Amphibia. Physiologically, they undergo peculiar modifications associated with the absorption of the yolk.

II. *The origin of the heart.* The embryonic heart is a bag with two layers—the pericardial epithelium and the endothelium. The latter, along with a number of wandering cells, arises from a group of mesodermic cells. The latter are continuous with the mesoderm of the head before the closure of the fore-gut, and are to be seen on each side between endoderm and pericardium (side-plates). When the fore-gut is complete they lie medianly in the interspace between the median portions of the pericardial plates, and laterally under the inferior pericardial plate. They give origin partly to the endothelium of the heart, and partly to the wandering cells.

III. *The embryonic circulation*, and IV. *The origin of the vessels on the yolk-sac*, are then discussed. None of Ziegler's results lend countenance to the origin of blood-corpuscles from the yolk.

V. *The origin of the blood-corpuscles.* It cannot be satisfactorily maintained that blood-corpuscles arise from the periblast elements. The wandering cells and the blood-corpuscles are of mesodermic origin. In many Teleostei the principal veins (median united cardinals) arise as solid cellular masses as in the chick. The cells within the vessels form the first blood-corpuscles. In some Teleostei the same process may be seen also in a portion of the aorta.

Ova of Bdellostoma.†—Mr. J. T. Cunningham briefly describes (*a*) the ovarian eggs of *Bdellostoma*, and notes the polar projections which, as in *Myxine*, are due to thread-like processes of the vitelline membrane; (*b*) the sexual organs, with the anterior part containing minute ova, while the posterior part was evidently testicular tissue. In one or two other specimens the whole organ seemed to be testicular. As in

* Arch. f. Mikr. Anat., xxx. (1887) pp. 596-665 (3 pls.).
† Trans. Roy. Soc. Edin., xxxiii. (1887) pp. 247-50.

Myxine, the breeding season is within the coldest season of the year. (*c*) In *Bdellostoma* the micropylar end of the vitelline membrane forms an operculum, which separates readily from the rest of the capsule, and would thus allow the escape of the embryo. (*d*) Mr. Cunningham then describes Teleostean ova of undetermined species, brought from the Gulf of Guinea by Mr. J. Rattray, and having filaments and vitelline membrane closely resembling those of *Myxine*.

Influence of Movement on Developing Eggs.*—Signor A. Marcacci has experimented on the effect of movement on the developing eggs of the fowl. During the period from 48–72 hours, at a temperature of 38° C., he moved them in various directions without any change resulting. But during the first two days such movement produced various abnormalities of thoracic wall, beak, claws, eyes, &c.

Significance of Sexual Reproduction.†—Dr. B. Hatschek, in regarding the significance of sexual reproduction, commences with assimilation, which he looks upon as the most important and probably original of vital phenomena. He affirms assimilation to be the sole known mode of producing fresh living substance. He supports his belief that in sexual reproduction we must recognize a remedy against the action of injurious variability by the experience of breeders that a certain degree of difference between the parent individualities is most favourable to the result of a crossing. Such differences as are caused in the organism by the external conditions of life would evidently be of no service in a sexual reproduction. A disease which made its appearance in an individual which propagated solely by gemmation would be inherited from generation to generation, and endanger the existence of the entire species. Mingling of sexual products would give not merely the possibility, but even the highest probability of a rectification such as can be obtained in no other way, and in this power of rectification Dr. Hatschek finds the chief use for the existence of sexually differentiated individuals.

Inheritance of Acquired Characters.‡—Prof. W. Detmer contributes some botanical facts to this now familiar discussion. As against Weismann's position he emphasizes (1) the intimate influence of external conditions upon the histology of the organism; (2) the importance of correlation whereby an influence saturates through the organism from one part to another; (3) the suggestiveness of the persistence of phenomena (like geotropism, photo-epinasty, periodicity of sap-flow) after the inciting conditions have ceased.

Ancestry of Man.§—Prof. R. Wiedersheim gives a most interesting and exhaustive account of the structures in the human body, which afford testimony of ancestral features. He devotes a hundred pages to a detailed discussion of the different systems, noting the points of interest which have been demonstrated in regard to each. He then distinguishes (1) progressive changes, towards further differentiation (9 cases); (2) retrogressive changes, in which the organs in question still retain functionality (12 cases); (3) retrogressive changes, in which the organs in question, either in fœtal or adult life, either constantly or occasion-

* Arch. Ital. Biol., ix. (1887) p. 58.

† Ann. and Mag. Nat. Hist., i. (1888) pp. 163–4. See Prager Mediz. Wochenschr., No. 46 (1887).

‡ Arch. f. d. Gesammt. Physiol. (Pflüger), xli. (1887) pp. 203–15.

§ Ber. Naturf. Gesell. Freiburg i. B., ii. (1887) pp. 1–114.

ally, persist, but have more or less lost their original function (78 cases!); (4) changes in which there has been change of function (6 cases); (5) changes associated with alterations in position (18 cases).

The author then sums up the theoretical conclusions of his survey, and occupying a position similar to that of his colleague Weismann, emphasizes the importance of natural selection in maintaining structures once established. As he says, natural selection has two sides—a positive side establishing adaptations, a negative side allowing the latter to degenerate when no longer essential. "As soon as changes in external conditions exclude an organ from importance in the struggle, that organ retrogrades. Panmixia, or general crossing, occurs between individuals, some with the organ in question well developed, and others with it less perfect; the result is, a slow but constant degeneration of the organ." The author's general conclusions as to the past and future of man are very vivid, and backed as they are by such an array of anatomical facts, most valuable and suggestive to the general naturalist, as well as to the anatomical expert.

Degeneration.*—Prof. A. Weismann gives a vivid account of degenerative or retrogressive changes in animal organisms. He discusses the wings of running birds, the blindness of cave animals, the rudimentary olfactory organs of cetacea, the retrogression of parasites, the loss of hair in some mammals, the sexual condition of worker ants, and many other familiar illustrations. The point of the whole discussion is to show that degenerations are not to be explained on Buffonian lines as due to direct influence or absence of influence from environmental conditions, nor on Lamarckian lines as due to the effect of disuse; but on Darwinian lines, by the action of natural selection, which is as necessary to sustain as it is to establish adaptations. The process by which a superfluous organ degenerates may be described as "panmixia," or "general crossing," in which not those individuals alone reproduce which possess the organ perfectly, but all, whether they have it developed in greater or less perfection. "Nature endures no luxury, no impulse or organ of the body has permanence, if it be not thoroughly necessary for the preservation of the species. Panmixia, or, if you will, the (non-) operation of natural selection, will secure that all the superfluous be gradually reduced to the absolutely necessary."

B. Histology.†

Histological Elements of the Central Nervous System.‡—Mr. F. Nansen commences this important essay by a very full historical account of the work of his predecessors. For the study of the structure of the nerve-tubes in invertebrates he has made use of the lobster, *Nephrops norvegicus*, various species of *Nereis* and other Polychætes, *Lumbricus agricola*, *Patella vulgata*, *Phallusia venosa*, and other Ascidians; he thinks that the general conclusions to which they have led him may be applied to all bilaterally symmetrical invertebrates. In these the nerve-tubes consist of an external consistent sheath with viscous contents; the sheaths are formed by, or belong to the connective substance extending through the whole nervous system, which the author calls neuroglia,

* Ber. Naturf. Gesell. Freiburg i. B., ii. (1886) p. 30.
† This section is limited to papers relating to Cells and Fibres.
‡ Bergens Museum Aarsberetning for 1886 (1887) pp. 29–215 (11 pls.).

and in them neuroglia-nuclei are more or less sparingly developed. The contents of the tubes consist of primitive tubes which are extremely slender or cylindrical, separated from each other by membranes of a firm supporting spongioplasm, which very much resembles the neuroglia substance; these slender tubes contain a hyaline, viscous substance—hyaloplasm, which is the real nervous substance, and is very often exuded from fresh isolated nerve-tubes in the form of small hyaline pearls. The fibrillæ and fibres described by most writers, do not, in Mr. Nansen's opinion, exist.

In many of the largish nerve-tubes of *Nephrops* and *Homarus* there is a concentration towards a kind of axis; this axis may be more or less narrow, and consists of a bundle of central primitive tubes which have stouter spongioplasmic sheaths and smaller diameters than the other primitive tubes. In the other animals examined this concentration cannot, as a rule, be observed; but there is a slight indication of it in some nerve-tubes of *Nereis*.

The ganglion-cells of all bilateral invertebrates consist of a nucleus with distinct membrane and a varying internal structure, and also of a protoplasm with various constituents; the cells are inclosed in a membrane of neuroglia substance. The principal constituents of the protoplasm are primitive tubes of the same structure as those in the nerve-tubes; some of them very frequently circulate concentrically round the nucleus, and so give a concentrically striated appearance to the ganglion-cells. In some, especially those of *Homarus* and *Nephrops*, the primitive tubes are partly united in bundles or in smaller or larger masses, which stain much more lightly than the rest of the protoplasm, notwithstanding the presence in it of a number of primitive tubes.

In very many, possibly in all, ganglion-cells, there is a spongioplasmic reticulation, extending from the inclosing neuroglia membrane into the protoplasm, between the primitive tubes and intimately connected with their spongioplasmic sheaths. In addition to this reticulation there is, probably, a special fatty (? myeloid) substance; it is not improbable that it is the same substance as that which in a number of animals is connected with a pigment (? hæmoglobin). The cells give off nervous processes and protoplasmic processes; of the former there is always one and never more; it is generally directed centrally, towards the dotted substance. The unipolar cell is the most common in bilateral invertebrates, but, when the cells are multipolar, the other processes are protoplasmic; these are generally short, and directed peripherally, and seem to have a nutritive function, being connected with the neuroglia. In structure and appearance they are quite similar to the protoplasm of ganglion-cells. Their contents are primitive tubes which spring from the protoplasm of the cells, and generally in such a manner as to converge uniformly from the whole protoplasm towards the pole where the nervous process issues; here they unite and form its contents.

The dotted substance is found to consist chiefly of nerve-tubes and primitive tubes (and nerve-fibrillæ, which are only small primitive tubes); these tubes consist of a neuroglia sheath, and semi-fluid contents (hyaloplasm), their structure only differing from that of the primitive tubes in the greater strength of their sheaths; these tubes and fibrils do not anastomose, but only form a more or less intricate web; the reticu ation seen in sections is not a true reticulation, but is

produced by the trans-section of the tubes, and the meshes of the reticulation are merely the trans-sected sheaths; the interfibrillar substance of authors is the hyaline hyaloplasm, which is the real nervous substance. The tubes and fibrils, of which the dotted substance is made up, consist of (1) the branches of the nervous processes that lose their individuality and are entirely broken up into slender branches; (2) the side branches of those nervous processes, which do not lose their individuality but directly become nerve-tubes, while giving off side branches on their course through the dotted substance; (3) the longitudinal nerve-cords which run through the dotted substance; (4) the side branches given off from those nerve-tubes; (5) the branches of such longitudinal nerve-tubes as are entirely broken up into slender branches and lose themselves in the dotted substance; (6) the slender tubes or fibrils which unite to form the peripheral nerve-tubes which exclusively arise from the substance; (7) the side branches joining those peripheral nerve-tubes which spring directly from ganglion-cells. In addition to tubes and fibrils, neuroglia cells and fibres are to be found in dotted substance; the nuclei generally have an oblong shape and a granular appearance.

The author next proceeds to discuss the combination of the ganglion-cells with one another, and the function of the protoplasmic processes; in spite of all his trouble Mr. Nansen has been unable to find any direct anastomosis between the processes of the ganglion-cells, and he does not think that, as a rule, such exists. With Prof. Golgi, he believes that the protoplasmic processes of the cells have a nutritive function, and that when the cells cannot get sufficient nutrition in their neighbourhood, they have to send out processes towards the periphery of the nervous system, or into the loose neuroglia reticulation, where there is sufficient nutritive fluid for the processes to absorb. If there is any combination between the ganglion-cells it must be due to the nervous processes. There are, it is to be remembered, two types of ganglion processes: some become directly nerve-tubes, and do not lose their individuality, while others are subdivided into a number of slender branches which are lost in the dotted substance; Mr. Nansen thinks it possible that these communicate with one another.

A brief preliminary notice is given of the nervous elements of *Amphioxus* and *Myxine*: it seems that they agree essentially with those of bilateral invertebrates.

In conclusion, the combination of the nerve-tubes is discussed, and the author suggests that in a reflex-curve the centripetal nerve-tube, the central web or interlacing of nervous fibrils, and the centrifugal nerve-tube are the sole elements; in other words, he believes that the ganglion-cells take no part in the matter; these last he looks upon as having nutritive functions, while the more the intelligence of an animal is developed, the more intricate becomes the web of nerve-tubes and fibrils in its dotted substance.

Artificial Deformations of the Nucleus.*—Prof. C. Van Bambeke finds that the nuclei of vegetable cells, of Arthropoda, and probably nuclei in general, show under certain conditions artificial deformations which throw light on the structure of these elements. These either affect the nuclear filament or several constituent parts of the nucleus.

* Arch. de Biol., vii. (1887) pp. 348–87 (3 pls.).

The study of nuclei which have been stretched, leads us to conclude that there is a viscous substance in the constituent parts of the nucleus, and notably in the nuclear filaments and the intermediate substance; the nucleoli are more consistent, and offer greater resistance to the causes of deformation. It is probable that the filaments of an intact nucleus are coiled and not arranged in a reticulum. In parts that have been stretched, filaments disposed in a parallel or radial manner are varicose, and their appearance often recalls primitive nerve-fibrils. There is often a partial fusion between the filaments and the intermediate substance; in certain cases the coalescence may be complete, and the appearance of parts, or even of the whole of the nucleus, may be homogeneous. Putting aside the nuclear membrane and the nucleoli, we may distinguish, in deformed nuclei, filaments and a homogeneous intermediate substance; the former appear to be formed of nuclein or chromatin and an achromatic substance; nothing but the latter gives any evidence of the existence of a reticulum of plastin.

Structure of Nerve-fibre.* — Dr. P. Schiefferdecker has reinvestigated the often attacked problem of the minute structure of nervous tissue. His main conclusions are as follows:—(1) The distinction of medullary and non-medullary nerves is a real one. (2) When there is a medullary sheath, both on peripheral and central fibres, this is doubly interrupted, by Lantermann's indentations which separate the various segments, and by the more widely separated constrictions of Ranvier. Both affect the whole thickness of the medullary sheath, and are seen on living fibres. (3) At both interruptions an intermediate substance lies between the medullary portions. This is readily dissolved away, but with silver solution and the like may be hardened. These annular plates ("Zwischenscheiben") are seen at Ranvier's constrictions, and funnels ("Zwischentrichter") at Lantermann's indentations. (4) Substances find their way into the axial cylinder most rapidly at the intermediate discs. They must be of especial nutritive importance.

(5) The medullary sheath possesses no peculiar nuclei. (6) While all central fibres lie naked in the supporting substance, all the peripherals have a connective tissue sheath, the sheath of Schwann. This begins at the origin of the roots from the central organ. (7) In the non-medullary this sheath lies close to the axial cylinder, in the medullary close to the medullary sheath, so close indeed to the latter that its contour is not usually visible. (8) Characteristic nuclei, surrounded by more or less protoplasm occur at intervals, and project markedly on the inner surface of the fibre. (9) The sheath forms a tube corresponding in form and size to the nerve-fibre. It is homogeneous, closed, and of uniform thickness. (10) It is constricted with the fibre at the intermediate discs, but this is hardly noticeable in young fibres. The more the medulla increases, the more Schwann's sheath grows, except at the intermediate discs where there is no medulla. Ranvier's constrictions have no influence on the sheath.

(11) The axial cylinder has the form of a more or less regular and continuous cylinder. (12) It exhibits an outer, firmer and thinner, an internal softer portion. (13) The outer "cortex" is very pliable, somewhat elastic, very fine. It swells in water, becomes for a short time more visible in dilute acetic acid. (14) The content is probably a

* Arch. f. Mikr. Anat., xxx. (1887) pp. 435–94 (1 pl.).

mobile, somewhat fluid, watery albuminoid substance. The inclosure of fibrils is possible, but not probable. (15) In contact with coagulating fluids, the axial cylinder shrinks up into very diverse forms. (16) Between the shrunken axis cylinder and the medullary sheath, or between the former and Schwann's sheath, a space is left. This contains coagulated material in small quantity, is the enlargement of a normal minimal space, probably containing a lymph-like nutritive fluid. (17) Osmium and other reagents produce a "coagulation-sheath" (Gerinnselscheide) on the surface of the axis. On this lie the silver precipitate and Frommann's lines. (18) Beyond the "cortex" there are no genuine sheaths—only artificial pseudo-sheaths. (19) Schiefferdecker here differs from Ranvier and from Boveri. (20) Weigert's hæmatoxylin blood-alkaline method stains the medullary fibres differently according to the chromic salt used in hardening. No special substance appears to be stained, the colouring varies considerably. After hardening in chromic acid, the medulla is little or not at all stained, but the cortex of the axis cylinder is, though not quite regularly. The irregularity in both methods depends apparently on the varying influence of the differentiating fluid.

Structure of Red Blood-corpuscles.*—Sig. F. Foà has made a minute study of the structure of red blood-corpuscles. These were stained after Ehrlich's method with methyl-blue, and decolourized by chromic acid 0·20 per cent. His results go to show that the red corpuscle is constituted as follows:—(1) A very delicate amorphous membrane; (2) a layer of hæmoglobin; (3) a reticulum of granular strands converging towards a central corpuscle which represents the residue of the nucleus; (4) the homogeneous protoplasm, probably in two physically different layers.

Hæmoglobin Crystals of Rodents' Blood.†—Prof. W. D. Halliburton has endeavoured to ascertain whether the six-sided crystals of the hæmoglobin from the blood of certain rodents really belong to the hexagonal system of crystallographers, and he finds that the presumption in favour of the hæmoglobin crystals of the squirrel and hamster being true hexagons is exceedingly great; those of the mouse do not, however, appear to be so. Another question which naturally arises is as to the difference of crystalline form that hæmoglobin presents in different animals, while its other chief properties are universally the same. It is clear that we have either to do with a case of polymorphism, or the crystalline forms are due to the combination of varying proportions of water of crystallization. As to the former suggestion, it is to be remembered that we have not yet a rational formula for hæmoglobin, while the conditions which are known to produce dimorphism in minerals —differences of temperature and of solvent—have no influence in the case of hæmoglobin. What is stated in the text-books as to the percentage of water of crystallization, would support the view that there is considerable difference as to its quantity; but Prof. Halliburton thinks that the variations may be due to the great difficulty in obtaining hæmoglobin in a pure state, and to the mode of investigation. Even if the difference in crystalline form is dependent on variation in the amount of the water of crystallization, no explanation is given as to the nature

* Arch. Ital. Biol., ix. (1887) pp. 28-9.
† Quart. Journ. Micr. Sci., xxviii. (1887) pp. 181-99.

of the agency that causes the hæmoglobin of some animals to unite with a certain amount of water of crystallization, and that of other animals with a different amount. But the author's recrystallization experiments seem to make it certain that some such substance or agency does exist.

B. INVERTEBRATA.

Parasites of Teredo navalis.*—Mr. W. F. Durand gives a brief and not technical account of the four parasites found by him in [region not stated] *Teredo navalis;* one appears to be allied to *Trichonympha agilis*, two others are probably Protozoa, and the last mentioned "has much the appearance of a nematoid worm." These "imperfect results of the first observations are given as a hint where a comparatively little worked field of examination may be found."

Fauna of Mosses.†—Dr. O. E. Imhof, excited by the work of Zelinka on the Callidinidæ, which live symbiotically with Hepaticæ, has examined various mosses. He has found a rich fauna made up of Rhizopods, Flagellates, Ciliate Infusoria, Rotifers, Anguillulidæ, Acarina, Arctiscoidea, and insect-larvæ.

Mollusca.

Microscopic Structure of Muscles of Molluscs.‡—Prof. H. Fol has directed his attention to the minute structure of the muscles of the Mollusca, as to which so little is certainly known. Notwithstanding the statements of various histologists, he has convinced himself that there is no true transverse striation in any mollusc. All the phenomena which have been explained as due to such striation are really caused by the spiral fibrils which surround the smooth fibres. The spiral turn varies in length with the number of fibrils, and with the state of contraction or relaxation of the fibre; in the mixture of glycerin and nitric acid used by Paneth the contraction is so great that the parts of the spire become almost transverse; and this fact explains the error of this writer.

Ingestion of Water in Lamellibranchs, Gastropods, and Pteropods.§—Dr. P. Schiemenz comes to the conclusion that those authors who, like Kollmann, Griesbach, and others, have asserted that there are Mollusca which can take in water by means of pores or clefts are correct; but, on the other hand, the animals in which they believe that they have demonstrated these orifices have not got them, and the water-pores they have described have no existence. He also brings forward evidence to show the existence of intercellular spaces; these are connected with the surrounding medium, but terminate in closed tips; they have nothing to do with the epithelial cells, as they are only evaginations of the basilar membrane. Delle Chiaje and his school were right in supposing the existence of a water-vascular system distinct from the blood-vascular, although such is not to be found in a number of molluscs in which they believed it to be present. Molluscs which have no closed blood-vascular system in the foot—such as Pteropods, Heteropods, Pulmonates, and,

* Amer. Mon. Micr. Journ., viii. (1887) pp. 224–6.
† Zool. Anzeig., xi. (1888) pp. 39–40.
‡ Comptes Rendus, cvi. (1888) pp. 306–8.
§ MT. Zool. Stat. Neapel, vii. (1887) pp. 423–72 (2 pls.).

probably, all Opisthobranchs—do not take in water; there remain, therefore, only the Prosobranchs, and among them the sand-dwellers appear to be especially endowed with this property.

α. Cephalopoda.

Growth of Cephalopod Shells.*—Mr. F. A. Bather discusses the two views as to the mode of formation of the shells of Cephalopods. The investigation of *Nautilus* led to the secretion-hypothesis, according to which the anterior portion of the mantle secretes calcareous matter, which it deposits in successive layers on the margin of the aperture. Dr. E. Riefstahl has been led to propose what may be called the intussusception-hypothesis. Microscopical investigation of the shell of *Sepia* seems to show that each septum is absolutely developed from the preceding, and is removed therefrom by growth of the intervening zone of the outer shell-wall; the growth being effected not by apposition, but by intussusception. Mr. Bather summarizes the evidence of Riefstahl, and urges certain objections; he thinks that facts do not confirm the intussusception-hypothesis, and that some of them do favour the old view of formation of the shell by secretion.

γ. Gastropoda.

Form and Development of Spermatozoa in Murex.†—M. R. Koehler has investigated the development of the spermatozoa in *Murex brandaris* and *M. biunculus*, where, as in various other Prosobranch Mollusca, these bodies are of two forms. A layer of parietal protoplasm contains numerous nuclei, whence originate all the seminal elements; but these nuclei, when they leave the protoplasmic layer, and become organized into cells, are of two very distinct kinds; some are large, and contain a large nucleus, have granular protoplasm and an enveloping membrane; these are the mother-cells of the vermiform spermatozoa. Others are much smaller cells, without any membrane, and connected by protoplasmic processes with neighbouring cells; these are the mother-cells of the filiform spermatozoa.

The large cells present a series of modifications, which first affect the nucleus; it becomes homogeneous, contracts a little, and loses somewhat the regularity of its contour; these changes are accompanied by a fragmentation of the nucleus, and an increase in the size of the cells; one of the nuclei produces a bundle of fibrils, one of the extremities of which will become the tuft of characteristic cilia, while the other will develope into a central filament. As the latter elongates, it meets the wall of the cell, and then enlarges to form the head of the vermiform spermatozoa. The author promises further details and a full justification of his belief that these spermatozoa are formed in the place of ova. He has observed that the mother-cells arise directly from the primordial sexual cells, like the ova in an ovary. If we admit that Prosobranchs are more ancient than Pulmonates, it seems justifiable to believe that this existence of two kinds of spermatozoa indicates a tendency towards hermaphroditism; the abnormally formed spermatozoa are very variable in form, and have no function; they get that of ova only when hermaphroditism is complete.

* Geol. Mag., iv. (1887) pp. 446–9.
† Comptes Rendus, cvi. (1888) pp. 299–301.

Development of Vermetus.*—Prof. M. Salensky's studies on the development of *Vermetus* commenced with the segmentation of the ovum, which follows the plan common to molluscs. The small macromeres that become formed have a mass of chromatic granules in the place of ordinary nuclei; this peculiarity seems to be due to the fact that these nuclei multiply indirectly. The cells of the secondary endoderm are the product of this division, and they likewise have masses of chromatic granules in the place of nuclei. Later on, the form of the secondary endoderm reproduces that of the embryo itself, and represents a mass of cells swollen at its anterior extremity and flattened posteriorly. The cells of the primitive endoderm—or, in other words, the macromeres—are so arranged that their protoplasmic portion faces the secondary endoderm; and in sections it may be seen that the protoplasmic portion of each macromere adheres to the cells of the secondary endoderm. The ectoderm which invests the dorsal surface of the embryo is formed of flattened cells; in some ova the anterior marginal cell is divided into two parts, one of which is at the edge of the blastopore, while the other takes part in the invagination; the latter represents the œsophageal cell. The marginal cells, which form the hinder edge of the blastopore, extend, primitively, in such a way that the blastopore represents a tube opening into the primitive invagination, which is filled by cells of secondary endoderm. The shell-gland appears early on the dorsal surface of the embryo, at a time when there are no evidences of the mesoderm; its history offers no peculiarity.

After sketching the early stages in the development of the organs of the body, the author proceeds to describe the mesoderm, the first appearance of which is late. This first appearance is very difficult to recognize, since the mesoblast first consists of a few scattered cells; these, which are placed between the cells of the ectoderm and those of the secondary endoderm, are difficult to detect, since the two primitive layers are applied to one another, and their cells only differ in the size of their nuclei. The mesoderm appears to be formed from the ectoderm, the cells which give rise to it multiplying directly. The rudiment of the mesoderm is arranged bilaterally, being formed, from the first, of two plates, which may be compared to the mesodermal stripes of Annelids. Independently of these there is, in *Vermetus*, a third, unpaired, rudiment, which the author calls the pericardiac mesoderm, but it does not appear till a later stage. The development of the eyes is somewhat remarkable; at the outer edges of the cephalic plates there appear two hemispherical thickenings of the ectoderm, and the eye is formed by a thickening of the cephalic plates with delamination. Behind them the cephalic plates become invaginated to form the cephalic ganglia; as the cells of the cups multiply, they form several layers of cells, and exchange their cylindrical for polyhedral forms. The formation of the fibrillar substance is due to the modification of the protoplasm of the cells of the invaginations; as they increase in size the cells become fibrillar. The eyes very early take on the form of spherical vesicles, owing to the extension of their cavity; but they still remain intimately connected with the rudiments of the cephalic ganglia, from which they do not become completely independent till a comparatively late stage. There is no doubt that the wall of the vesicle is converted into the retina.

* Arch. de Biol., vi. (1887) pp. 655–759 (8 pls.).

The pedal ganglia and otocysts arise independently, and the former are rather late in appearing; the first signs of them are well-marked thickenings of the ectoderm, which may be called pedal plates.

After describing the formation of the pharyngeal commissure and the peripheral nervous system, the author deals with the glands of the foot. Of these there are, as in other molluscs, two, quite distinct from one another.

The differentiation of the mesoderm is dealt with in some detail. As in other Ctenobranchs, there is a provisional and a permanent heart. From the morphological point of view, the spaces which are in relation with the former correspond to the cavities of the circulatory organs of the adult, and are, like them, the remains of the blastocœl. The author is inclined to think that the embryonic heart has a purely ectodermal origin, and that it is derived from a vesicular invagination of that layer. Its external wall is formed by ectoderm, the cells of which are remarkably modified, becoming fusiform and elongated in the direction of the long axis of the embryo. Although there is not yet full direct evidence, we may suppose that the cavity of the heart is in communication with those of the velum. The permanent heart is formed from the dorsal unpaired rudiment of the mesoderm.

The temporary renal organs which are often found in molluscs seem to be absent from *Vermetus*. The permanent kidney appears very late; the mass of mesodermal cells from which it arises is at first placed in the anterior ventral angle of the pericardiac cavity.

The ectoderm gives rise to the œsophagus, and the endoderm to the intestine and rectum. From the first there arise three outgrowths, the median of which forms the radula-sac, and the two lateral the salivary glands. In the formation of the intestine the greater part of the central mass of the endoderm is converted into a nutritive mass; the boundaries of the cells disappear, the nuclei become swollen, lose their contour, and are resolved into a finely granular substance, which soon fuses with the protoplasm of the cells.

At the conclusion of this description of the facts which he has observed, Prof. Salensky proceeds to consider the formation of the embryonic layers of *Vermetus* in connection with the ancestral form of the Metazoa. He is not satisfied with the Gastrula of Haeckel, the Planula of Ray Lankester, the Parenchymula of Mecznikow, or the Plakula of Bütschli. He believes that the first differentiation which characterizes the passage of the colonial Protozoa to the prototype of the Metazoa consisted in the division of cells into motonutritive and genital; this idea was simultaneously conceived by Götte and the author; it has a close relation to the question of the origin of the blastopore. The difficulty of the disappearance of this orifice, and the appearance of secondary ones, cannot be explained by physiology, but the facts become readily comprehensible if we admit that the ancestral form of the Metazoa must be sought for in vesicular colonies of Flagellates, developing on the type of the *Volvox* of the present day; the blastopore would correspond to the orifice seen in young colonies of *Volvox*, and it, we know, disappears in the course of development. The hypothetical organism for which we are searching would differ from the actual *Volvox*, in that the cellular individuals of the colony would be capable of animal nutrition, such as is probably the case in *Protospongia*. Like *Volvox*, the hypothetical ancestor of the Metazoa would be capable of

forming genital cells; these were probably amœboid, like those of *Protospongia*, and, after separation from the wall of the colony, would fall into the genitocœl, as the cavity of the colony may be called.

We know that, in *Volvox*, daughter-colonies may give rise to parthenogonids before leaving the mother-colony, and that they sometimes do so before their orifice closes; the same may justly be supposed to have happened with the ancestral forms of the Metazoa, and, as it would be an advantage, we should have forms passing the greater part of their existence as open vesicles, strongly charged with parthenogonids; this open stage is regarded as the prototype of the Metazoa, and is called the *Genitogastrula*. In the limited space at their disposal, only some of the parthenogonids would arrive at maturity, while others would retain their amœboid form; in this way we get genital cells and nutrient cells; for the inner layer composed of them Prof. Salensky proposes the term *Phagogenitoblast*, while he retains for the outer layer, formed of amœboid cells, the name of *Kynoblast* proposed by Mecznikow. The internal nutrient cells could only function if their colonial orifice remained open, and it would be advantageous, therefore, for it to be so till the moment of the maturation of the sexual products, and the formation of daughter-colonies; the expulsion of the embryos would necessitate the formation of one or more orifices of exit, and it would be a matter of indifference whether or no these corresponded to the primitive opening.

In the development of the Metazoa the same modifications are seen, and the blastopore is to be regarded as the remnant of the colonial orifice, while the new openings (mouth and anus) are connected phylogenetically with the appearance of a secondary orifice in the colonies of Flagellates.

Prof. Salensky thinks that two types have been confounded under the term blastula; whether it is formed by delamination (schizoblastula) or immigration (porcioblastula), the blastula is palingenetic, and corresponds to a closed colony of Flagellates; but in the Gastroblastula, Amphiblastula, Archiblastula, Periblastula, and Discoblastula, there have been cenogenetic alterations; the cavity has appeared precociously.

The author next discusses the formation of the mesoderm, which is, as he justly says, one of the most obscure problems of comparative embryology; the more observations have multiplied, the clearer has it become that the mesoderm arises in different ways. To him it appears to be a complication of the primordial diploblastic form of the Metazoa; this is shown by the existence of Metazoa in which there is no mesoderm, and the development of this layer subsequently to that of the ecto- and endoderm. If we can imagine that, for some reason—the growth of the genitogastrula, for example—the vibratile cells, which served for the locomotion of the organism, were not sufficient for its movement, and that this want brought about a gradual adaptation of the deep amœboid cells to the needs of locomotion, we should get a contractile layer formed between the ectoderm and the genito-endoderm. It would be indifferent to the organism whether these mesodermic cells arose by immigration of new cells or from cells that had previously immigrated; in either case there would be a triploblastic gastrula, but in one the mesoderm would appear to have its origin from the endoderm, and in the other case from the ectoderm.

In conclusion, Prof. Salensky discusses the phylogenetic relations of

the Mollusca to the bilateral animals; after discussing the developmental history of the nervous system, the differentiation of the mesoderm, the formation of the cœlom, and the development of the heart and pericardium, he thinks sufficient evidence is afforded of the relationship of the Mollusca to Annelids; but this raises the question of segmentation, and we know that the postoral part of molluscs is not segmented. To explain this, it is necessary to suppose that the deviations from the ancestral form common to the two groups began at a larval stage, and have since been gradually impressed on the organization of the animal.

Anatomy and Affinities of Ampullaria.*—M. E. L. Bouvier adds to our knowledge of this amphibious mollusc, the nervous system of which he has already described. It has both a monopectinate gill like all the Monotocardia, and a false bipectinate gill like the most highly organized of that group. The false gill lies to the left of the lung and the true gill to the right; both are innervated by the left supra-intestinal branch of the visceral commissure, and so correspond to the same organs on the left side of other Monotocardia. The left kidney is a large chamber with the floor alone glandular; the spiral portion of the intestine, the ovary and albumen-gland of the female, and the seminal reservoirs of the male project on to this floor, and appear to be situated in the cavity of the chamber. The cavity of the left kidney communicates anteriorly and on the right with that of the right kidney; the latter is lined by lamellæ arranged around a dorsal and a ventral vein. The renal products make their way to the exterior by a cleft in the walls of the right kidney; they pass into a conical canal which ends at a groove placed between the recto-genital mass and a dorsal lamellar pad. As in *Haliotis*, the venous blood from the left kidney goes directly to the heart, while that from the right kidney first passes to the gills.

The anterior part of the digestive tracts recalls by its relations to the nervous system and the salivary gland the diotocardate Prosobranchs; there is a gastric cæcum, and the intestine is coiled spirally in the cavity of the left kidney. As has long been known, the circulatory system is remarkable for the presence of an arterial ampulla which is lodged in the pericardium and situated at the base of the anterior aorta. The posterior aorta is replaced by five arteries, one of which branches on the wall of the intestinal spire.

Notwithstanding certain anatomical resemblances to the Naticidæ and the diotocardate Prosobranchs, the Ampullariæ appear to be closely allied to the Paludinidæ, and especially to the Cyclophoridæ; but a little more than either of these they tend to approach the higher Prosobranchs.

Development of Heart of Pulmonate Mollusca.†—Mr. W. Schimkewitsch has a note on the investigations into the development of the heart of pulmonate molluscs lately made by M. Schaalfeew. The latter gentleman has studied *Limax agrestis*, and he finds that the pericardium first appears as a compact accumulation of mesodermic cells in which the pericardiac cavity is, later on, formed by delamination. The heart arises as a thickening of the inferior wall of the pericardiac vesicle. The dorsal wall gives rise to a fold which divides the pericardiac cavity into two parts; of these the right forms the glandular part of the organ of Bojanus, while the excretory duct is formed from

* Comptes Rendus, cvi. (1888) pp. 370–2. † Zool. Anzeig., xi. (1888) pp. 64–6.

an ectodermic thickening. We may therefore conclude that the organ of Bojanus, like the nephridia of Annelids, is formed partly by ectodermic and partly by mesodermic cells. The resemblance is the more complete, if, with Grobben, we regard the pericardiac cavity of molluscs as the homologue of the cœlom of Annelids. The disappearance of one pericardiac vesicle and one organ of Bojanus is evidently correlated with the general asymmetry of the body in these molluscs. If the pericardiac cavities are cœlomic in nature, then the inner walls of the pericardiac vessels correspond to the dorsal mesentery of Annelids.

Sucker on Fin of Pterotrachea.*—Mr. J. W. Fewkes points out, not with a view of claiming priority, but to corroborate succeeding writers, that in 1883 he observed—as Paneth and Grobben have since—that the sucker on *Pterotrachea* is not confined to the male of this Heteropod.

δ. Lamellibranchiata.

Histology of Najadæ.†—Herr I. Apáthy publishes a summary of his Hungarian monograph on the histology of Najadæ.

I. *Blood.* The corpuscles (e. g. of *Unio*) have manifold forms, and are not characterized by few and short processes as Flemming described. A special form is distinguished by large nucleus, almost absent processes, and absence of tendency to unite with others. The nuclei of the corpuscles were observed in indirect division. The pericardial fluid is not blood, though corpuscles may wander into it.

II. *Connective tissue.* The hyaline intercellular substance with its clefts is characteristic. Physiologically, the elements may be distinguished as (*a*) proper connective tissue cells, producing the intercellular substance; (*b*) mucous cells without share in the latter. A nucleus is present in all these. A portion of the fine fibres on the walls of the blood-vessels belongs to the connective tissue system. Fine fibrils are also demonstrable in the hyaline matrix, especially if celloidin be used for imbedding. The cells without processes, which Kollmann describes as "Häutchenzellen," are more or less altered and shrivelled cells, which no longer fill their original space in the matrix. The mucous cells may retain their mucus within their membrane (Langer's Bläschen), or empty it by a distinct canal (mucus-cells proper). There could be no doubt as to the intactness of the vesicular cells, which are certainly not "lacunæ." There is a continuous transition between the latter and the glandular mucous cells with distinct openings. The mucus secretion, and in part the shell secretion, pertain to the connective tissue system.

III. *Epithelium.* This is always in one layer. There is no proper endothelium. Every epithelial layer has a cuticle, even that which bears cilia. The cuticle is a cementing substance. The superficial pigment differs from that of connective tissue, glands, or nerves, in being more finely granular and much less soluble in alcohol or ether. The basal portions of the cilia are connected with the cellular protoplasm by narrow processes penetrating the cuticle. Engelmann's conclusions as to the histology of the cilia are considerably modified. Flemming's tactile brush cells occur over the whole surface of the body. They are really double; the spindle-shaped, darkly pigmented, superficial portion

* Zool. Anzeig., xi. (1888) pp. 64–5.

† Naturh. Abh. Ung. Akad., xiv. Cf. Biol. Centralbl., vii. (1887) pp. 621–30.

is epithelial, the subjacent club-shaped, yellow coloured portion is a peripheral ganglion-cell. The epithelium of the rectum is peculiar. The auditory sac includes two different types of epithelial cell, one wineglass-shaped, the other retort-like.

IV. *Muscular tissue.* The muscle-fibres are surrounded by connective tissue. There is no sarcolemma. The cardiac muscles have an unusually large protoplasmic region round the nucleus, greater in mass than the contractile substance. The contractile substance is a product of the muscle-cell. The primitive fibrils of the contractile substance are histogenetic homologues of the connective tissue fibrils. Unstriped muscles are found in adductors and in mantle. No true transverse striation was found. The fibres multiply only from muscle-germ-cells, which persist even in the adult organism. The division of the nucleus of a fibre is a subordinate, persistent embryonic process.

V. *Nervous tissue.* In the nervous system ganglionic and nerve-cells have to be distinguished. The former are starting-points for the nerve-fibres. The latter lie imbedded between the primitive fibrils of the nerve-fibres; they produce the fibres. The fibres show no membrane or myelin sheath; they correspond to axial cylinders, or rather to Remak's fibres in vertebrates. The branching of the fibres is then described. The long nuclei of the nerve-fibres or nerve-cells are, like those of the muscle-fibres, surrounded by a protoplasmic mass, continued in a long process at the poles. H. Schultze confused these cells with connective-tissue cells, which lie not in, but between the nerve-fibres. Between the several ganglion-cells, fine processes of the connective tissue were demonstrable. Dogiel's apolar ganglion-cells occur both in connection with the cardiac muscles and elsewhere. The nerve-terminations innervating the epithelial cells of the mantle-margin, end in minute round plates. In the adductors, the nerve-terminations penetrate the fibres in the nuclear regions. They consist of an axial thread or primitive fibril, surrounded by a pale sheath, probably of interfibrillar substance. Only the axial thread enters the muscle-fibre, the latter loses itself on the surface. The axial thread may be traced into the protoplasmic mass of the muscle-fibres, and never seem to end in the contractile substance.

Molluscoida.

α. Tunicata.

Classification of Tunicata.*—Prof. E. van Beneden thinks that the discoveries of the last few years necessitate a revision of the classification of Tunicates. He here confines himself to some critical notes, and the formation of a new genus. The genus *Ecteinascidia* of Herdman shows that the modes of reproduction cannot be taken as a basis of classification. The author has lately been able to investigate Philippi's little-known genus *Rhopalæa*, and with it he places *E. crassa* and *E. fusca* of Herdman. For *E. turbinata*, in which there is no division of the body into thorax and abdomen as in the preceding, a thin and not cartilaginous test, as well as other differential characters justify the generic separation of this species, with which *E. diaphanis* of Sluiter may be associated. For the species *E. rubricollis* Prof. van Beneden proposes the new generic term of *Sluiteria*; the distinction may be justified on the ground that its test is provided with conoid papillæ, and traversed by stolonial tubes (vessels

* Bull. Acad. R. Sci. Belg., lvi. (1887) pp. 19–47.

of the tunic) as in most Ascidians; there are well-developed siphons, and the orifices are widely separated, the dorsal plate is formed by a well-developed continuous membrane, the alimentary canal has a different course to that of *Ecteinascidia*. The generic characters of the three genera are systematically stated.

Histology of Salpa.*—Dr. C. S. Dolley has made an investigation into the histology of *Salpa*. He thinks that the cuticle is, like the outer mantle of *Doliolum* and the "house" of *Appendicularia*, shed from time to time, and renewed. The inner mantle is said to consist of an ectodermal and an endodermal cellular layer, which are separated by a hyaline connecting substance in which lie buried the viscera and the muscular bands, and through which a network of blood-sinuses burrows in all directions. The ectoderm consists of a single layer of pavement epithelium, in which the cells have the protoplasm occupying the central portion, while the rest of the cell appears to be empty and transparent; the author has been unable to find large pavement-cells containing a protoplasmic reticulum extending out from a central plasma-mass, as described in the larvæ of *Doliolum* by Uljanin and Grobben; but in several young specimens he has found a layer of epithelial cells lining the cavity containing the clæoblast, and these present an appearance which corresponds in almost every particular to that described by Uljanin.

The muscles are composed of from six to twelve broad, flat, striated fibres arranged in bundles, with their broad surfaces in contact, and their edges looking outwards and inwards. The fibres are made up of several muscle-cells which have become fused together; each fibre has a large number of oval nuclei, which are clear and bladder-like and have relatively large nucleoli.

The gill is found to be perforated by an irregular series of blood-sinuses, and not by a "single grand sinus" as described by Prof. Huxley. The endostyle of *Salpa runcinata-fusiformis* differs considerably from that described by Fol in so many *Salpæ*; there is no "middle intermediary band"; the "outer intermediary band" does not consist of simple pavement cells, but of three layers of spindle-shaped cells with rod-like nuclei.

The number of cæcal appendages would appear to vary in different species; the observation of Seeliger that no food is ever found in them is confirmed. Dr. Dolley believes with H. Müller that they have an hepatic function. The author's objections to the presence of intercellular digestion in *Salpa* have been confirmed by Seeliger. The existence of cilia for moving on the contents of the intestine is necessitated by the absence of any musculature in connection with the visceral nucleus. The delicate tubes which spread over the visceral network consist of an extremely thin basement membrane, bearing cuboid cells, in which no nucleus was visible. The testes consist of a number of delicate tubes, in which a basement membrane is scarcely apparent; the walls are formed by a layer of clear round cells containing pear-shaped bodies.

The nerve-ganglion presents a nearly spherical mass covered with a delicate membrane, which seems to be continuous with the outer sheath of the nerve-trunks. The visual (or as Huxley called it auditory) organ is a continuation both of the central fibrillar core, and the external layer of ganglion-cells; outside its nervous central portion is a layer of rather

* Proc. Acad. Nat. Sci. Philad., 1887, pp. 298–308 (1 pl.).

large cylindrical cells, which contain in their inner halves a round nucleus, and a quantity of dark pigment; the pigment-cells are in their turn covered by a layer of columnar cells; the latter layer appears to be a modified portion of the ectodermal layer of the inner mantle. Dr. Dolley supposes that the eye of *Salpa* is compound. The ciliated sac consists of a simple tube closed at the end nearest the ganglion, against which it rests, and opening at the other end into the branchial sac; its walls are made up of short, thick, columnar cells carrying heavy cilia.

β. Polyzoa.

Reproductive Organs of Alcyonidium gelatinosum.*—Prof. W. A. Herdman has had his attention directed to a colony of *Alcyonidium gelatinosum*, which was not, as is usual, homogeneous in colour and semi-translucent, but had a blotched appearance, due to the presence of a number of small rounded spots of an opaque greyish-white or pale yellow colour. These spots were found to be cavities which were filled with fully developed active spermatozoa; on further examination, some of the polypides of the colony were found to contain a few young ova. Prof. Herdman thinks that *A. gelatinosum*, like many of the compound Ascidians, is an hermaphrodite in which the reproductive systems arrive at maturity at different times in the life-history, but, whereas these are proterogynous, *Alcyonidium* appears to be proterandrous. If the polypides are unisexual, then this proterandry applies only to the colony, but it is possible that each polypide may be a proterandrous hermaphrodite. Both ova and spermatozoa occur in ordinary polypides, and not, as in *A. mytili*, in gonœcia, or cells which contain no polypides.

Anatomy of Pedicellina.†—Dr. A. Foettinger has detected on the coasts of Belgium a third species of *Pedicellina*, which he calls *P. benedeni;* it is characterized externally by a pedicle formed of numerous segments, recalling that of *Urnatella gracilis* Leidy, and by the rosy colour of its tentacles. In its anatomical characters it agrees closely with *P. echinata* and *P. belgica;* simple or multiple bands may appear on the joints of the pedicle. In all three species the segmental organs are formed of two tubes which terminate at their central extremities in a cell provided with a long vibratile filament; the two tubes unite to open by a single orifice which is placed at the level of the intertentacular space; they are formed of a small number of cells, and their cavities are intracellular. All the forms examined were found not only to have the sexes separate, but individuals of one sex formed distinct colonies. The male organs consist of two testicles, which pour their secretion into a seminal vesicle, from which arises a long excretory duct which opens near the external orifice of the segmental canals. The female apparatus consists of two ovaries, in the interior of which short oviducts arise; these unite into a common canal which ends on the floor of the incubatory chamber, not far from the anterior wall of the intestine. Glandular cells are connected with the common canal and oviducts, and their contents are probably used to form the egg-shell. The oviducal apparatus not only serves for the extrusion of ripe ova, but also for the introduction of spermatozoa; these elements are, indeed, found in the ovaries themselves.

The central nervous system is represented by a brain more or less

* Nature, xxxvii. (1887) p. 213. † Arch. de Biol., vii. (1887) pp. 299–329 (1 pl.).

distinctly divided into two lateral lobes; it is formed of a granulo-fibrillar mass enveloped in a nucleated cortex. Several pairs of nerves are given off symmetrically from its surface. In *P. benedeni* the brain is always in front of the ovaries, in *P. echinata* it is partly between them, and in *P. belgica* it is completely surrounded by them.

Arthropoda.

Eyes of Arthropods.*—Dr. W. Patten, finding that his observations on the structure of the adult eyes of insects differed widely from those of other recent writers, has endeavoured to confirm, by embryological data, the continuity of the so-called rhabdom with the crystalline-cone cells, and also his observations on the nature of the corneal hypodermis, or, as he now prefers to call it, the corneagen. As the compound eye and optic ganglion of *Vespa* develope slowly, and the successive stages are clearly defined, it is an admirable subject for investigation.

Among the more important points which this investigation has brought out are—

(1) The crystalline-cone cells, or any of the eventually pigmented cells surrounding them, do not form a layer of cells distinct from and superimposed on the retinulæ; for the crystalline-cone cells, the retinulæ, and the other pigmented cells are derived from, and remain a single layer of cells.

(2) The rhabdom is not a product of the retinulæ, but is merely the inward prolongation, or stalk, of the crystalline-cone cells.

(3) The layer of cells from which the ommateum arises is the inner wall of an optic vesicle formed by an invagination of the ectoderm, and the ommateal cells are consequently upright.

(4) The retinophoræ which, in the adult, are grouped in fours, are in the youngest stages arranged in twos, or repeat the permanent condition of the retinophoræ in the ocelli of most insects, and in the simpler compound eyes of Crustacea.

(5) The pigment first appears in the form of paired patches around the paired retinophoræ, and is retained until after the retinophoræ have increased to four. This transitory condition of the ommatidial cells in the compound eye probably corresponds with the permanently paired arrangement of the pigment patches and retinophoræ of the ocelli. At the commencement of the pupal stage the eye consists of three layers, the innermost being the ommateum, the middle layer being composed of cells containing large round nuclei, arranged at regular intervals over the retinophoræ, and the third of flattened cells with quite small nuclei; the last is but slightly modified in the adult, where it forms the corneagen. The cells of the middle layer become sickle-shaped and arrange themselves in pairs, a single cell on either side of a calyx. They grow inwards as far as the neck of the calyx, where they terminate in a rounded swelling containing a large nucleus; their inner ends soon become deeply pigmented, and appear to form a part of each ommatidium. Surrounding the sickle-shaped cells are the ends of a circle of eighteen more cells, so that each ommatidium, including the four retinophoræ, but not the two middle-layer cells, is composed of twenty-two cells.

The author is of opinion that the difference between his results and those recently obtained by Reichenbach on *Astacus* is more one of interpretation than of observation. His own observations and those of

* Journ. of Morphology, i. (1887) pp. 193-226 (1 pl.).

Kingsley appear to make it certain that the ommateum is a single layer of cells, and consequently Reichenbach's crystalline-cone layer represents the whole ommateum, and corresponds in its early stages to the optic thickening of *Vespa*. If this be so, it is clear that the outer wall of Reichenbach's "Augenfalte" cannot develope into the layer of retinulæ and rhabdoms. It is probable that the "optic invagination" of Kingsley, the "Augenfalte" of Reichenbach, and the ganglionic fold of Patten are one and the same thing.

To show that his view as to the three-layered nature of the ancestral Arthropod eye is correct, it was important for the author to demonstrate that the eyes of *Dytiscus* and related forms, which have been described by Grenacher as open cups, and as the simplest type of Arthropod eye, are really closed vesicles primarily composed of three layers of cells. The author has examined the ocelli in the larvæ of *Hydrophilus*, *Dytiscus*, and *Acilius;* in the last of these there are six pairs of cells, of which the two dorsal pairs are very deep, and resemble the two-layered ocelli of certain spiders; the space between the lens and retina is completely filled by a layer of very long cells—corneagen—whose deep nucleated ends are somewhat swollen and bent away from the centre of the eye; they are so arranged that there are no nuclei of the corneagen just above the centre of the retina, while there is a distinct layer of them over its periphery, as well as on the walls of the inner half of the eye. The periphery of the corneagen contains a thin layer of very large dark globules, many of which contain a still darker corpuscle; this layer of pigment-like bodies extends from the edge of the lens to the retina. The floor of the eye is formed by a layer of upright retinal cells, each provided with a double rod, and there is a median furrow.

In *Hydrophilus*, the ocelli are formed by invaginations of the ectoderm directed diagonally inwards, and the ocellus is composed of three distinct layers of cells, of which the thick inner layer, the retina, is directly continuous on the dorsal side with the hypodermis. The eye is not really but only practically a closed vesicle, as is shown by the absence of nuclei at one point and the continuity of the three layers. Dr. Patten comes to the conclusion that there are ocelli in the larvæ of insects very similar to what, in a former paper, he regarded as the ancestral eye of Arthropods.

Taking a more extended survey, the author finds himself led to the supposition that the dorsal and ventral eyes of *Phronima* and *Gyrinnus*, and those of the males of *Bibio* and *Cloë*, as well as the dorsal and ventral parts of the eyes in Libellulidæ and *Euphausia*, are homologous with the dorsal and ventral halves of the larval compound eyes of *Vespa*. The parts of the compound eyes of *Vespa*, and in all probability of most other insects, are in turn homologous with the posterior upper ocelli of *Acilius* and their dorsal extensions. In such cases as those seen in the larvæ of *Corethra* and Phryganids, the ocellus has already become a compound eye, whilst its dorsal extension does not attain that perfection until the imaginal stage is reached.

α. Insecta.

Dermal Sensory Organs of Insects.*—Herr O. v. Rath has a preliminary notice of his investigations into the structure of the dermal

* Zool. Anzeig., x. (1887) pp. 627–31, 645–9.

sensory organs of Insects. He finds that, with the exception of the optic and auditory organs, they are all modifications of a single type, which is thus described. With the stout chitinous covering of Arthropods, sensory perceptions are obtained by the intermediation of more or less modified hairs. Some of these are, externally, so little different from ordinary hairs, that it is only by the sensory cells at their base that we are able to distinguish them; others have definite forms, and sometimes a membrane-like plate of chitin is formed by the flattening out of the basal portion and the reduction of the proper hair; in this case the plate closes superiorly the canal which traverses the chitinous layer. This is the case with the so-called closed pits of the Hymenoptera and with similar organs found by the author on the antennæ of Beetles (e. g. *Cetonia*); these he proposes to speak of as membranous canals.

Hair-like structures may be found on the surface of the cuticle, or rise up from the base of a more or less deep pit in the chitin (so-called sensory cones); one pit may contain two or more sensory cones, as in the antennæ of various Diptera; the cases in which a whole area beset with a number of sensory hairs has been invaginated to form a large vesicular pit, are especially interesting; such are the large pits of the antennæ of the Muscidæ, and the large flesh-like pits which the author has found at the tip of the labial palp of Lepidoptera. By a similar process many simple chitinous pits may be united into a single large pit; such are to be seen in the antennæ of the cockchafer.

At the base of each sensory hair there is occasionally a single sensory cell, but in most cases there is a group of cells; the former may be seen in the labial palp of the Lepidoptera, where a distinct process of a single large sensory cell enters each sensory hair. The sensory cells are supplied by a nerve entering from behind, and the cells themselves give off long fine processes into the hair-like structures. The group of sensory cells is invested in an envelope of connective tissue, which consists of flat cells with flattened nuclei. When a number of sensory hairs are united on one area, the groups of sensory cells which belong to them may likewise be formed into a compact mass. In this apparently single ganglion the arrangement of the cells can be made out, and their connective-tissue investments detected; such aggregations of sensory cells may be well seen in the palps of *Melolontha* or *Coccinella*.

In the antennæ of some insects, the palps of *Coccinella*, *Chrysomela*, and *Cetonia*, or the gustatory organs of Hymenoptera, groups of special large cells may be seen beneath the groups of sensory cells, in the neighbourhood of the nerves; notwithstanding their position, it seems to be certain that these are not special sense-cells.

The author proceeds to state what sensory organs he has observed in different groups of Insects, into the details of which it is impossible for us to follow him.

Salivary glands of Insects.*—Herr A. Knüppel has examined the structure of the salivary glands of insects, especially *Blatta orientalis*, and has come to conclusions which are not in accord with those of Prof. Kupffer. He finds, in fact, that the enlarged origins of the efferent duct are not intracellular, but extracellular in *B. orientalis;* on the other hand, in the cells of proboscis-glands of the Diptera, there are secretion-spaces, which are connected with the efferent ducts of the gland-cells;

* Arch. f. Naturgesch., lii. (1886) pp. 269–304 (2 pls.).

these spaces have proper walls. A certain change may be observed in the morphological appearance of the secreting organs of one and the same species, and this is dependent on the active or passive condition of the cell. The hemipterous species *Pyrrhocoris apterus*, the dipterous *Musca domestica*, *Homalomyia canicularis*, *Calliphora erythrocephala*, *Lucilia* sp., *Eristalis arbustorum*, *E. tenax*, &c., were also examined.

Sense of Direction in Formica rufa.*—Dr. H. C. M'Cook gives an account of his observations on the structure of the ant-hills, and the character of their roads and engineering skill in *Formica rufa*, as seen in the Trossachs of Scotland. He finds that the ants showed an accurate sense of direction in marking out and following their approaches to the trees. It would be scarcely possible to attribute such mathematical accuracy as they exhibit to mere accident. The roads were as accurately laid down as ordinary roads made by the engineering skill of man.

This skill in the ants was all the more apparent from the fact that their paths were carried through a jungle of bracken and other plants. No facts were observed which justify speculation on the manner in which this feat of engineering was accomplished. Sentinels stationed near the ant-hills exhibited great alertness; the finger of Dr. M'Cook was observed at about an inch or an inch and a half's distance; the sentinels thrust out their antennæ, extended their heads, then their front legs, and finally the middle legs, while the abdomen was slightly turned underneath the body, as though prepared to eject formic acid on any adversary.

Respiration of Hydrophilus.†—Herr v. Fricken describes the mode of aquatic respiration in *Hydrophilus aterrima*, *Hydrocharis caraboides*, and *Piceus*. He saw that they store up the air, not under the wing-covers, but in the hairy covering of the under surface. The air is caught and renewed, not as in *Dytiscus* by raising the posterior end of the body above the surface of the water, but, as Nitsch recorded, by forming a small whirlpool by means of the antennæ, the first joint of which projected above the surface of the water.

Aorta of Bombyx mori.‡—Signor S. Selvatico finds in *Bombyx mori*, as Burgess has observed in other Lepidoptera, that the aorta is bent anteriorly and widened out into a kind of chamber, which has about the form of an equilateral triangle, with the apex directed downwards; from the basal angles two vessels are given off, one of which goes to the optic ganglion and eyes before opening into the lacunar passages; the other extends all along the interior of the antennæ. At the base of the antennæ the vessel widens, and contains a peculiar spherical structure, which is attached to its wall by special fibres; this is apparently an apparatus for closing the lumen of the vessel. The author draws attention to the fact that in *Bombyx mori* the supra-intestinal nerve passes into the interior of the aorta and extends some distance along its lumen.

Larva of Culex.§—Herr E. W. Raschke gives a careful and detailed account of the anatomy of the familiar larva of *Culex nemorosus*. While useful as a sufficiently exhaustive account of a form which has not been

* Proc. Acad. Nat. Sci. Philad., 1887, pp. 335–8.

† Biol. Centralbl., vii. (1887) pp. 633–4. (60 Versamml. Deutsch. Naturf. u. Aerzte.)

‡ Zool. Anzeig., x. (1887) pp. 562–3; also in Pubblicazioni R. Stazione Bacologica Sperimentale (Padova) 1887, 19 pp., 2 pls.

§ Arch. f. Naturgesch., liii. (1887) pp. 133–63 (2 pls.).

carefully studied since the time of the older naturalists, the memoir contains little of moment that can in any way be called new or of general interest. The mouth-organs, the directive hairs, the manifold respiration, the nervous system, are well described, and the accompanying figures are very good.

Some Species of Chermes.*—M. N. Cholodkovsky finds on young Siberian cedars (*Pinus cembra*), on warm days in spring and summer, woolly masses, which can even be detected in winter if the snow be shaken off the branches. In winter and early spring these consist of wingless females of *Chermes* which have outlived the winter; in the second half of April they lay amber-yellow stalked eggs; in the second half of May winged examples may be seen laying their eggs. This species is allied to *Chermes strobi*. Soon there appear a number of small yellowish-brown wingless individuals, which push their long proboscis-setæ deeply into the tissue of the needles of the cedar; these the author regards as the sexual generation of this species of *Chermes*. Another species has eggs which outlive the winter, and from which in spring wingless forms are developed; for this latter form the author proposes the name of *C. pectinata*, and for the one which has some resemblance to *C. strobi* that of *C. cembræ*. If the eggs which have survived the winter are fertilized eggs, the resemblance of the life-history of *Chermes* to *Phylloxera* would be more complete than Dr. Blochmann has imagined it to be.

β. Myriopoda.

Post-embryonic Development of Julus.†—Mr. F. G. Heathcote has followed up the post-embryonic development of *Julus terrestris*.

(1) *Cœlome*. The somites divide into two parts, one in the body, the other projecting into the legs; the cavities together form the cœlom. That within the legs breaks up, and the cells form muscles. The body-part unites dorsalwards along the thin sheet of mesoblast which unites it to its fellow; the two vesicle-like parts meet medianly above the nerve-cord so as to form a single generative tube. The body-parts of antennæ and mandibles disappear; those of the third pair form salivary glands; there are two pairs of somites to each double segment. (2) *Generative organs*. The ova and follicle cells are proliferated from the walls of the above-mentioned generative tube. (3) *Nerve-system*. There are two cerebral grooves as in *Peripatus*, disappearing early; the double ventral cords concentrate in one; the cavities of the ganglia vanish early; there are two ganglia to each double segment. (4) *Tracheæ* arise as epiblastic invaginations behind the legs; swell into two vesicles, each with two diverticula, which break up to form the tracheal tubes; there are two pairs of invaginations to each double segment. The stink-glands are epiblastic invaginations, with a muscular coat superadded later, one pair to each segment. (5) *Heart* arises from mesoblast cells in body-cavity. These cells were derived from hypoblast, form a network, and the heart by a joining of the meshes of this network. The heart has two pairs of arteries into spaces of fat-body, two pairs of ostia, an imperfect pericardial membrane continuous with fat-bodies, and three coats—two muscular and an outer connective. The fat-bodies arise from above mesoblast network. (6) *Body-cavity* is a pseudocœle, distinct from the

* Zool. Anzeig., xi. (1888) pp. 45–8. † Proc. Roy. Soc., xliii. (1887) pp. 243–5.

cœlomic cavities of the somites. (7) *Eye-spots* arise from thickening of hypodermis, and formation of pigment-lined vesicle. The front wall thins into lens, the cells of most internal wall and sides become retinal; the pigment-cells of Grenacher are probably mesodermic; a connection with the ganglion-cells of nervous system is early established.

The most striking feature is the reduction of the ventral, and the increase of the dorsal part of the young animal. The relations are the same as those in carboniferous *Euphoberia*. Each double segment represents two complete segments, the dorsal plates of which have fused into one.

δ. Arachnida.

Vision in Arachnids.*—Prof. F. Plateau, in continuation of his previous memoirs, gives an account of the observations which have been made by himself and by others on the power of vision exhibited by Arachnids. After describing his separate experiments with about a dozen species of spiders, he sums up the general results as follows:—(1) The Araneidæ in general perceive at some distance the displacements of large objects; (2) the hunting spiders (Attidæ, Lycosidæ) are probably the only forms that see the movements of small bodies; (3) they perceive these movements at a distance which varies in different species from 2–12 centimetres; (4) the distance at which the prey is seen distinctly enough to induce an attempt to capture it, is only 1–2 cm.; (5) even at this slight distance the vision is not exact, for the hunting spiders make numerous errors; (6) the non-hunting web-making spiders have very poor vision, they only perceive the presence and the direction of their prey by the vibrations of the filaments, and will seek to capture little bodies quite other than insects if the vibrations produced on the web be somewhat similar.

The author then discusses the vision of scorpions. His experiments with *Buthus europæus*, taken along with Ray Lankester's observations on other species, show that the vision is very poor; that the distance of distinct sight is not more than 1 cm. for the median eyes, and 2½ cm. for the laterals; that the animals do not really hunt, but rather wait on luck; that feeling is, both in locomotion and in dealing with their prey, vastly more important than sight.

Lastly, Prof. Plateau discusses the Phalangidæ. His experiments show that they stand at about the same sensory level as the web-making spiders. The vision is very poor, distinct sight hardly at all developed for any distance. The Phalangidæ make up for this, however, by the exquisite development of their appendages, and especially of their pedipalps.

Respiration of Arachnida.†—Prof. F. Plateau has made some experiments by the graphic method which demonstrate the absence of perceptible respiratory movements in these animals. There is some doubt as to whether there are any transverse muscular fibrils in the pulmonary plates of Arachnids; none such are figured by Prof. Ray Lankester, and Mr. Locy says expressly that he has failed to demonstrate the muscular differentiation described by M. MacLeod. Prof. Plateau, having performed his part as experimenter, looks to the histologist to resolve the disputed point in minute anatomy.

* Bull. Acad. R. Sci. Belg., xiv. (1887) pp. 545-95 (1 pl.).
† Arch. de Biol., vii. (1887) pp. 333–48.

Regeneration of Lost Parts.*—Herr V. Wagner discusses the intimate nature of the processes which take place when a spider regenerates a lost appendage. He describes in order the formation of the chitinous knob, the atrophy of old tissues, the growth of the new part. His general results are the following:—(1) The blood-corpuscles metamorphose to give rise to a tissue resembling chitin. (2) The fatty degeneration of the old tissues benefits the organism in three ways—(*a*) by supplying material to be digested and utilized by amœboid cells; (*b*) by supplying matter to be absorbed by the coloured blood-corpuscles; (*c*) by the direct benefit of the diffusing fatty globules. (3) Without the blood-corpuscles the process of regeneration probably could not occur. (4) The process of degeneration in the muscular tissue of spiders is, in general terms, like that which occurs in vertebrates. (5) The integument, matrix, and subcutaneous layer of connective tissue do not arise from new elements, but the old non-atrophied tissues grow with peculiar power in good nutritive conditions. The spider must be tolerably young—that is, have some few moults before it—if the appendage is to be wholly renewed. The lost organ is replaced in the period of time between two successive moults at the stage of development at which it was lost. The palp cannot be completely regenerated if it is lost late—that is, when the copulatory apparatus has arisen.

Age and Habits of American Tarantula.†—Dr. H. C. M'Cook commences with a tragic account of the death of Sir J. Lubbock's aged ant-queen, which, in the course of last year, attained the age of thirteen years; but he concludes with the publication of a note from Sir John, saying that in January 1888 the "venerable sovereign of the emmet world," as Dr. M'Cook calls it, was still alive. Passing to his proper subject, Dr. M'Cook records the death of a specimen of *Tarantula* which had been in his possession for more than five years, and which was certainly seven and may have been eight years old. He ascribes its great longevity partly to human protection. With regard to its habits the author observes that the act of moulting is frequently attended with danger of some kind or another to spiders. To keep spiders alive, it is better to underfeed than overfeed them, but they must always have a supply of fresh water, and should be kept at a moderate temperature. In spinning, the animal slowly moved its whole body round as upon a pivot, and so dispersed the silk over a circular patch. The only nest of the *Tarantula* is a burrow in the ground, and it does not, as is often supposed, make any trap-door. There are interesting notes on toilet-habits and on the character of the egg-cocoon.

Distribution of Arachnida.‡—Two years ago, Prof. O. Zacharias discovered in the little Iser a new species of Hydrachnida, which Herr F. Körnke named *Sperchon glandulosum*. He writes now to note the fact that at a similar elevation (800 metres above the sea), and in similar conditions in the Azores, the same species is, according to Barrois, quite abundant. As it is very rare in Germany—never found, in fact, except in the first locality—this further discovery is interesting.

* Bull. Soc. Imp. Nat. Moscou, i. (1887) pp. 871–99 (1 pl.).
† Proc. Acad. Nat. Sci. Philad., 1887, pp. 369–86.
‡ Biol. Centralbl., vii. (1887) pp. 631–2.

c. Crustacea.

Excretion in Brachyurous Crustacea.*—M. P. Marchal, noting that the excretory system of the Decapoda has hardly been investigated, except in the crayfish, has made an investigation into that of *Maia squinado*. He finds that the apparatus consists of gland, reservoir, and excretory duct; the two reservoirs are of enormous size, and occupy the whole of the sternal part of the cephalic region in front of the mouth. Each consists of a vestibule, a proper bladder, and a hind-bladder; where the two latter unite, the orifice of the gland is hidden under a bridge of tendon; the excretory duct opens at the antero-external part of the bladder, in a funnel-shaped depression formed by the vestibule.

The excretory orifice is, during repose of the apparatus, hidden by a calcareous plate; but when the elevator muscle, which is connected with it, contracts, the plate is raised, and the chitinous membranes which are inserted into it are exposed; the excretory orifice is thus able to evacuate the excreted liquid. A crab under examination was seen to put its tubercles into movement twice in an hour and a half; the tubercle is kept raised for some moments, is then lowered, and moved backwards and forwards several times so as to get rid of the last drops of the fluid. At the same time the palps of the second and third gnathites emerge and set up a very rapid undulating movement, the object of which is, evidently, to drive away the excreted fluid from the mouth and branchial cavity.

The bladders of either side are not, necessarily, emptied at the same time, and appear to be independent of one another; the emptying of the bladder is brought about by the action of muscular bundles, and the organ has, possibly, some contractility of its own, while the action of the tubercle appears to have a favourable influence on the emission of the liquid. On the other hand, the oblique course taken by the canal causes the two lips to be applied against one another, and so to close the entrance when the pressure is from the exterior; the opposite happens when the pressure is from the interior.

The quantity of fluid excreted is considerable, a single crab of 780 grammes weight giving in a few seconds 13 c.cm. and one as much as 17 c.cm.; the liquid is perfectly limpid, with a strong saltish taste, and of a density (with the urinometer) of 1030.

Green Gland of Crayfish.†—Herr B. Rawitz answers Prof. Grobben's strictures on his conclusions as to the structure of the green gland of *Astacus*. He remains of his own opinion, and his response has little more than personal interest.

The Bopyridæ.‡—Prof. A. Giard and M. J. Bonnier have published a monograph on the Bopyridæ, various preliminary notices of which have been given in this Journal. In the present memoir the Ioninæ and Entoniscidæ only have been considered; for each a type has been selected, for the former *Cepon elegans*, which is parasitic on *Pilumnus hirtellus*, and for the latter *Entoniscus* (or, as the authors call it, *Portunion* g. n.) *mænadis*, which is parasitic on the common shore-crab, being taken. The history of each of these forms is considered in detail. In addition, systematic summaries are given.

* Comptes Rendus, cv. (1887) pp. 1130-2.
† Arch. f. Mikr. Anat., xxxi. (1888) pp. 98-9.
‡ 'Contributions à l'Étude des Bopyriens,' 4to, Lille, 1887.

Two New Genera of Epicarida.*—MM. A. Giard and J. Bonnier have found new forms of these Bopyridæ, parasitic on specimens of *Palæmon* brought from the fresh waters of Dutch Malaysia, and probably from the island of Amboyna. That which Semper named *Bopyrus ascendens* they call *Probopyrus ascendens*, and the other *Palegyge Borrei*. The former is distinguished from *Bopyrus* by the characters of the pleon in both sexes; that of the female has appendages which appear to have escaped the notice of Semper, and that of the male has traces of the lateral appendages which are completely wanting in *Bopyrus*.

Palegyge bears to *Gyge* the same relation that *Probopyrus* has to *Bopyrus*, for they represent a less degraded form which has retained the typical Ionid structure of the pleon.

An interesting parallelism may be drawn between the phylogenetically archaic nature of the parasites and their hosts, for *Palæmon dispar* and *P. ornatus* are older than *P. serratus*, *P. squilla*, and others on which *Bopyrus* is parasitic; the older forms have survived, owing to their inhabiting fresh or brackish water.

Lernæascus and the Philichthydæ.†—Prof. C. Claus has been able to make a more complete study of the little parasitic Crustacean which is found on the skin of *Solea monochir*, which he named *Lernæascus nematoxys*. He gives a detailed account of the male, of the young stage, and of the mature female. He also describes the female forms of the allied *Philichthys* and *Sphærifer*. On *Lernæascus* he notes the presence of 50–60 pairs of dorsal and ventral scale-like structures or cuticular thickenings which appear to serve as delicate locomotor organs.

Without attempting to summarize the exact results of Claus's anatomical investigations, we shall quote his diagnosis of the family to which he refers *Lernæascus* and its allies. The Philichthydæ are completely or almost completely segmented parasitic Crustaceans, with only two pairs of copepod appendages modified as organs of attachment, and with a rudimentary third pair. The male, like that of the Lernææ, is small, with normal, distinct, segmentation, with an eye divided into three, with two pairs of antennæ and maxillæ on the head, and with dorsal integumentary appendages on the second thoracic segment. The fourth and fifth segments of the thorax are without appendages. The two testes are shifted to the terminal portion of the abdomen. The female, like that of a Lernæa, is large out of proportion, usually with indistinct segmentation, with an eye in three portions (if it be always present), with an enlarged second and third thoracic segment, which, by themselves, or plus the next segment, are fused in a distended portion. On this, and on the head, as also on the genital and terminal segments, there often arise, as in many Chondracanthæ, paired outgrowths. The feeling antennæ always remain separate. The attaching antennæ may be degenerate. The mouth-area with the maxillæ is very definitely circumscribed, and surrounded by a wide short tube. The two double-branched and the third simple pair of appendages are minute and rudimentary. The receptaculum and genital apertures are dorsal. Both sexes live in mucous canals of the fish skin. Prof. Claus then diagnoses the separate genera *Philichthys*, *Sphærifer*, *Leposphilus*, *Lernæascus*. In *Sphærifer*, only the females are known.

* Comptes Rendus, cvi. (1888) pp. 304–6.

† Arbeit. Zool. Inst. Wien, vii. (1887) pp. 281–315 (4 pls.).

First Changes in Fecundated Ovum of Lepas.*—Prof. M. Nussbaum finds that the processes of maturation and fecundation of the ovum of *Lepas* arrange the living parts in such a way that on the extrusion of the directive corpuscles all the axes of the future animal are already defined. The position of the corpuscles indicates the future position of the cephalic end of the embryo; the first and second segmentations take place along a plane which will be the future long axis of the animal. If the relative position of the axis continued as at first, it might be thought that the contents of the ovum alone possessed the power of orientation. But, as the first plane of division passes from a longitudinal to an equatorial plane, the envelope and its form must also possess directive powers; these may be best explained by the principle of least resistance. By this principle we may also explain the fact that the first division, though it takes place in the longitudinal direction, does not divide the ovum into the materials for the right and left halves of the body. The rigidity of the egg-capsule causes it to be the essential regulator of the position of the developing embryo of *Lepas*.

Vermes.

a. Annelida.

Development of Annelids.†—Prof. M. Salensky finds that three stages of development play an important part in the evolution of worms. They succeed one another in a definite order in the development of the embryo, and consequently did so in the evolution of the phylum. They may be called the *Trochogastrula*, the *Trochophora*, and the *Trochoneurula*.

The *Trochogastrula* represents a stage which is common to all worms, and which serves as the genetic bond between the different classes of this group; it is in the form of a bilateral gastrula, the body of which is divided into a preoral and a postoral portion, the former of which contains the occipital plate. There is no anus; the ciliated velum of the gastrula is sometimes retained.

The *Trochophora* represents a further stage, which is characterized by the appearance of an anus and of a postoral ring, as well as by an increase in the size of the postoral region of the body.

The *Trochoneurula* is characterized by the development of medullary plates. Comparative embryology shows that the different classes of worms pass through one, two, or all three of these stages, and the classification of worms may, in consequence, be thus formulated:—

(A) The Platodes only pass through the Trochogastrula stage.

(B) The Nemerteans and the Rotifers pass through the Trochogastrula and the Trochophora stages.

(C) The Annelida and Gephyrea pass, in addition, through the Trochoneurula stage.

The development of Nematohelminths presents enormous difficulties to a comparison of their development with that of other classes of worms, while they have no metabolic (larval) forms. Future researches may throw further light on this problem.

The author proposes to divide the worms into two groups, one of which he calls Cephaloneura, and the other Neuraxonia. The former,

* SB. K. Preuss Akad. Berlin, 1887, pp. 1052–5. Ann. and Mag. Nat. Hist., i. (1888) pp. 161–2.

† Arch. de Biol., vi. (1887) pp. 589–653 (1 pl.).

which contains the Platodes, Nemerteans, and Rotifers, are only provided with cephalic ganglia and cerebral commissures; the latter, which contains Annelids, Gephyrea, and Nematohelminths, are provided with cephalic ganglia and a ventral ganglionic chain. The nervous system of the last of these is stated by Götte and Ganin to consist of four rudiments, two dorsal and two ventral; these very early unite into a single ring. If this be so, the dorsal rudiments are probably the homologues of the occipital plate, and the ventral rudiments those of the ventral ganglionic chain. But the author acknowledges that further researches are needed to demonstrate the legitimacy of the systematic arrangement which he proposes to base on these embryological data. *Sagitta* has a still closer resemblance to Annelids and Gephyrea, for the nervous system is formed of two rudiments, and there is a true cœlom; in Nematodes the mesoderm does not become delaminated into splanchnic and somatic layers, and only gives rise to the longitudinal muscles.

The unarmed Gephyrea diverge from the Annelid type of development much more than do the armed Gephyrea; in *Sipunculus* there is only a rudiment of the pre-oral ciliated circlet, while in *Phascolosoma* this is quite absent and the postoral circlet developes very early.

Vascular System of Hirudinea.*—Dr. A. G. Bourne refers to M. Jaquet's paper on the vascular system of Annelids. He regrets that the author's interpretations tend to take us back to a condition of things which existed forty years ago, and he ascribes this defect to M. Jaquet's want of appreciation of comparatively recent work on the subject. Dr. Bourne makes some critical remarks on various genera of leeches which have been incompletely described by M. Jaquet.

Structure of the Eye of Branchiomma.†—M. C. Brunotte has examined the structure of the eyes in *Branchiomma*, where, as is well known, there is an eye at the tip of each of the branchial filaments. The ocular mass does not completely surround the cartilaginous axis of the branchia, there being towards the internal side a non-pigmented zone covered by epithelial cells which are identical with those on other parts of the gill. Examination in sea-water, aided by pressure, reveals the presence of facets; there is no difference in the characters of the cuticle; in sections each elementary eye is seen to have the form of an elongated triangle, with its base turned towards the periphery. Directly below the cuticle there is a small spherical lens, and underneath it there is a nucleus of some size situated in a sort of rounded cavity. The author compares the lens and cellular body with its large nucleus to the crystalline formations of Arthropods; the cell is inclosed in a granular protoplasmic mass, in which an anterior, granular and protoplasmic portion, in which there is another nucleus, may be distinguished from a hinder part which contains an elongated refractive body. This last is regarded by M. Brunotte as the optic rod of the visual cell; its narrow internal end is continuous with nerve-filaments. There is no trace of pigment in this region, but special pigment-cells surround each of the elementary eyes.

The author is of opinion that in *Branchiomma* we have to do with a true compound eye, which differs from any which has yet been described in Annelids. Grenacher and Carrière have always given the name of

* Zool. Anzeig., xi. (1888) pp. 16-8. † Comptes Rendus, cvi. (1888) pp. 301-3.

visual cells to those that are pigmented, but Patten, on the other hand, states that in Annelids, Arthropods, and Molluscs, the visual cell never contains pigment; the axial nervous filament which the last-named writer always finds in visual cells has not been detected in *Branchiomma*. The eye of the Annelid may be regarded as being formed of two layers, the more superficial of which furnishes the dioptric apparatus, while the lower gives rise to the sensory elements.

Larval and Definite Excretory Systems in Lumbricidæ.*—Prof. F. Vejdovsky has examined the larval stage of seven Hungarian species of Lumbricidæ, and finds in all these common characteristics: looked at from above or below the larvæ are more or less ovoid, ellipsoidal, or spherical; the unilaminate epiblast is ciliated on the ventral surface, and the larvæ are thereby enabled to execute more or less lively rotatory movements in the albuminous fluid; the anterior end is distinguished by three (more rarely four or five) larval cells; these have been hitherto incorrectly called "Schluckzellen," but they must be regarded as contractile epiblast-cells belonging to the larval excretory system; they arise very early, and some species may be recognized during segmentation by their intracellular network of canaliculi; later on they are overgrown by smaller epiblast-cells, and come to lie between the epi- and hypoblast. Fine ciliated canaliculi are connected with these gland-cells; in *Lumbricus rubellus* there is generally only one pair of these excretory canaliculi; the excretory fluid is gradually collected in the intracellular ducts, which loop in various, but no doubt definite fashion, and the clear fluid is, by a sudden contraction, expelled to the exterior through a dorsal orifice. The larval canaliculi have begun to function at the time when the two large mesoblasts begin to divide, and they are consequently undoubted derivates of the epiblast.

The remnant of the blastopore goes to form the stomodæum; below it the anterior ends of the germinal stripes are united; these now grow on either side of the stomodæum, and so give rise to the first segment. The multiplying elements of this segment gradually press the glandular cells of the larval excretory apparatus a little backwards into the median dorsal line. The larval excretory canaliculi and the contractile gland-cells do not disappear until the second and third segments are completely developed.

Independently of these larval excretory organs, a pair of straight non-ciliated excretory canals become developed in the dorsal cœlom of the first segment; these are what the author has called the embryonic or provisional excretory organs. They degenerate without leaving any vestiges, while in the succeeding segments the excretory organs become developed. These arise by the increase in size and division of a pair of mesoblast-cells on the posterior side of the dissepiment of each segment, which grow into a short solid cord; this very rapidly grows out into a large group of cells, which make the exact study of the process of nephridium-formation of Lumbricidæ very difficult to follow.

In young forms of *Rhynchelmis*, however, it is possible to follow out the process step by step, for after the digestion of the yolk-elements the worm is quite transparent. Each nephridium passes through a remarkable cord-like stage which may be called the pronephridium; after the formation of the solid cord of cells a large cell arises anteriorly which

* Zool. Anzeig., x. (1887) pp. 681–5.

projects into the segment in front; this soon gets a lumen in which a very long active cilium may be seen; this closed ciliated cell appears to be wanting to the pronephridia of the Lumbricidæ; the orifice of the cell may be called the pronephrostom. Just behind the dissepiment the cells of the cord increase and gradually form a lobe which grows dorsally and forms loops; this lobe corresponds to the dorsal cell group in the solid cords of Lumbricidæ. The ciliated cell of the pronephrostom has meanwhile divided several times until at last it becomes converted into a plate-like structure, at the margin of which fine and short cilia begin to beat. In this way the pronephrostom is converted into the funnel of the definite excretory organ, and it becomes continuous with the duct which, later on, appears in the dorsal lobe. Finally, the remainder of the primitively straight cord acquires a lumen, and as soon as the contractile bladder is formed by the invagination of the hypodermis the definite nephridium is in full activity.

It follows from this description that we have in the Annulata to distinguish three kinds of excretory organs :—

(1) Larval excretory organs which have nothing in common with the definite organs.

(2) Pronephridia of developing segments which only function for a short time.

(3) Nephridia, developed from the pronephridia; these degenerate in the second to sixth segments of most Oligochætes, but are found in those that succeed them.

Reproductive Organs of Moniligaster.*—Mr. F. E. Beddard thinks that the account given by M. Perrier of the reproductive organs of *Moniligaster deshayesi* is incorrect, but that his description may be brought more into accord with those of Dr. Horst and himself. He points out that in numerous characters the reproductive organs of this worm resemble certain limicolous forms; such are the identity of the "prostate" with the atrium of *Stylaria lacustris;* the funnel of the vas deferens is a simple disc-shaped expansion, and not plicated; the vasa deferentia themselves resemble those of the Naidomorpha in being single, and in being contained in two segments; and the male pores are placed on the boundary line between two segments, as is commonly the case among limicolous, but never the case in terricolous Oligochætes. These facts may be urged against the division of Oligochæta suggested by Claparède and endorsed by many systematic writers.

So-called Prostate Glands of Oligochæta.†—Mr. F. E. Beddard points out that the vasa deferentia of some earthworms are not furnished with any special glands (e.g. *Lumbricus*, *Microchæta*). Where such are present they belong to one or other of two types; in *Acanthodrilus*, *Trigaster*, and others, they have the form of an elongated, often contorted, tube, of an opaque white colour; in *Perichæta*, *Megascolex*, and others, they are composed of numerous lobules, more or less loosely connected together, and opening by a number of ductules into a common duct. When we investigate the two questions—Do these various structures correspond to each other? and, Are they homologous with any organs found among the lower Oligochæta?—we are led to the conclusion that the so-called prostate of *Perichæta* is the homologue of the atrium in other earthworms and in the Limicolæ; it is, then, clear that under the

* Zool. Anzeig., x. (1887) pp. 678–81.

† Ibid., pp. 675-8.

term prostate two organs have been confounded—the atrium of Perichæta, *Acanthodrilus*, &c., and the atrium and prostate of *Moniligaster*.

Histology of Pachydrilus enchytræoides.*—For this marine Oligochæte, M. L. Roule finds it necessary to form a new genus, and he proposes to call it *Enchytræoides Marioni*. The ventral nerve-chain exhibits a simplicity of histological structure which calls to mind the arrangements in Archiannelids. There are nerve-cells along its whole length, and these are placed in the lower part of the band; there are no aggregations or thickenings which could be called ganglia; the band is, further, intimately connected with the ectoderm, not, indeed, along the whole of its length, but at a number of points which appear to regularly succeed one another. The nephridia are thick oval bodies, with a wide vibratile opening; their interior is hollowed by a flexuous canal which opens by a very small ventral pore; this canal is hollowed out of the cellular substance itself.

New Earthworm.†—Dr. W. B. Benham has a preliminary note on a new earthworm, which is very interesting from the fact that it possesses two pairs of nephridia in each somite. As it is very short in proportion to its length it is provisionally called *Brachydrilus*. The setæ are exceedingly minute. The spermathecæ differ in structure and position from those of any other earthworm except *Microchæta*; they are small and oblong. This new worm has—like *Lumbricus*, but so far as is known no other Oligochæte—capsulogenous, or, as Dr. Benham, with Vejdovsky, prefers to call them, albumen-glands; their lumen is lined with short columnar cells which are surrounded by a layer of muscles, and outside these are the large glandular cells with very granular contents. Each nephridium corresponds in position to one of the couples of setæ, and those of each side are quite separate from one another; the organ somewhat resembles that of *Lumbricus*, but the tube is much less coiled. Dr. Benham inclines to the view that the nephridia of Oligochætes were primitively, as they are still in many species of *Perichæta*, numerous scattered tufts of tubules; with suppression of some there has been increase in size of others, and some in certain somites have taken on the function of genital ducts.

Organization of Annelids.‡—Herr E. Meyer has an elaborate memoir on the organization of Annelids. He commences with an account of the nephridial system of the Terebelloidea—a name formed for a group containing the Terebellacea, Ampharetea, and Amphictenea. This group is remarkable for the internal division of the anterior body region, which is ordinarily known as the thorax, into two unequal chambers, each of which consists of a number of segments. These two divisions are separated from one another by a strong muscular diaphragm. The anterior is the smaller, and contains, as a rule, only the head and the gill-bearing segments; the hinder one is always much larger and is often continued into the abdomen. In both, the ordinary dissepiments are completely wanting. In most cases the septa in the abdominal region are broken through at definite points, so that all the segmented chambers of the abdomen communicate not only with one another, but also with the post-diaphragmal space of the forebody. The

* Comptes Rendus, cvi. (1888) pp. 308–10. † Zool. Anzeig. xi. (1888) pp. 72–5.
‡ MT. Zool. Stat. Neapel, vii. (1887) pp. 592–741 (6 pls.).

gonads are placed in the hinder thoracic chamber. With these anatomical and physiological differences are correlated certain local differentiations of the nephridia.

The whole number of the nephridia is proportionally small in the Terebelloidea; the anterior pairs which communicate by their internal orifices with the cavity of the prediaphragmal segments have, ordinarily, small infundibula, while their tubular excretory portion may attain considerable dimensions; their function is exclusively excretory. In the nephridia of the hinder thoracic segment the funnel is generally the most prominent part, being often of enormous size; the ducts, on the other hand, are poorly developed. These organs appear, therefore, to be especially adapted for taking up finer bodies swimming in the cœlom, and have the function of efferent ducts for the genital products; with this, they seem to lose their excretory function. All the nephridia of the Terebelloidea open within the area of the somite to which they belong, and they open to the exterior separately and independently of one another; their ciliated infundibula are always intersegmental in position, and always open into the next preceding segment. In all these worms the nephridia are confined to the thorax.

After an account of his macroscopical and microscopical investigations of *Amphitrite rubra*, *Lanice conchilega*, and *Melinna palmata*, the author points out how greatly they differ from one another in the details; we may take it that, typically, the nephridia are developed in a moderate number of pairs (about six) in continuous series, beginning from the third segment; but they may begin further back, or the series may be broken by the loss of a pair; the presence of more than one pair of nephridia in a segment is a rare occurrence. There are never more than three pairs in the anterior chamber, the diaphragm being typically placed between the fourth and fifth segment; this position of the diaphragm is characteristic of group A or of the Amphitritea, Polycirridea, Corephoridea, and Trichobranchidea; in group B, which consists of the Ampharetea and Amphictenea, there is only one pair of nephridia, the diaphragm being placed between the third and fourth segments. In *Pista cristata* alone has the complete absence of the anterior nephridia been noticed. A relatively large number of hinder nephridia is rare, but there are never less than two pairs. A tabular statement is given of the number and arrangement of the nephridia found in the species which were examined.

As a rule the nephridia of either side are distinct from each other in all Annelids, but in *Lanice conchilega* and *Loimia medusa* there are nephridial ducts, by means of which the organs of opposite sides are brought into connection.

The peritoneal glands and their products are next described; these are the gonads, the lymph-glands, and the pigmented lymph-glands.

In discussing the functions of the nephridial system, Herr Meyer states that in *Amphitrite rubra* he has found that the protoplasm of the cells gives rise to two kinds of excretory products; these are pigmented crystalline concretions, and clear excretory fluid in vacuoles; and the cells that produce them are found to be localized separately. As the nephridial tubes are often surrounded by a close vascular network belonging to their peritoneal investment, it is more than probable that some of the excretory materials are obtained directly from the blood.

From what has already been said it is clear that there is a division

of labour between the anterior and posterior nephridia. In the former the epithelium of the extraordinarily well-developed tubular portion has a very large excretory surface, and the pigmented lymph-glands are in their neighbourhood. In the seasons when the sexual organs are inactive it is probable that the chief function of the hinder nephridia is to destroy and remove the used up lymph-corpuscles from the body. When the gonads are active they take up their products from the cœlom and conduct them to the exterior.

The development of the permanent nephridia of *Polymnia nebulosa* is next described; and this is succeeded by an account of the larval organs.

Passing to morphological conclusions, the author discusses the relations between the ciliated funnel, the nephridial tube, and efferent canal, and the morphological relation of the nephridial passages to the tubes. The funnels are shown by the history of development in *Polymnia* to be peritoneal funnels in the true sense of the word; the nephridial tubes arise from a retro-peritoneal tissue, and are therefore morphologically distinct from the peritoneal funnels. With regard to the efferent canals, the continuity of their epithelium with the hypodermis, the histological resemblances between them and certain parts of the skin, and their sharp limitation from the inner cell-layer of the nephridial tube speak to their ectodermic origin. The passages appear to have arisen from one and the same embryonic tissue as the nephridial ducts. The typical condition of the funnels, and the influence exerted on them by the change of the branchiæ and branchial vessels are next considered; and this is followed by a consideration of the significance of the renal septa in *Amphitrite rubra*. The ancestors of the existing Terebelloidea must have had nephridia in the whole of the thorax, and the ciliated infundibula of these were all provided with the upper lips which are typical for this group.

The author believes that the information he has acquired justifies a reconstruction of the nephridial system of the nearest ancestors of *Lanice* and *Loimia;* they had, he thinks, two long nephridial ducts, which began anteriorly in the third somite and extended uninterruptedly through, at least, the whole thorax; in each segment there was a pair of nephridial tubes with typical infundibula, and there were as many efferent ducts in the external pores. He does not now attempt to homologize this arrangement with that of the archinephric system of Vertebrates, and contents himself with comparing the two from a purely anatomical standpoint. It will be remembered that Mr. J. T. Cunningham published a short time ago* an account of his observations on the nephridia of *Lanice conchilega*. Herr Meyer points out the few points in which his observations diverge from those of the English anatomist.

With the remaining portions of Herr Meyer's paper we must deal much more briefly. The excretory and genital organs of the Cirratulidæ are next considered, a detailed account being given of the nephridia of *Chætozone setosa;* the vascular system and the peritoneal glands are also described. The concluding section deals with the nephridial system of the Serpulaceæ and Hermellidæ; the hinder organs or genital tubes of these groups agree generally with the typical annelidan nephridium, but the thoracic nephridia offer some very remarkable differences. The

* See this Journal, 1887, p. 591.

union of the nephridial tubes of one pair on the back, and the presence of a common unpaired efferent duct are, so far as the author knows, peculiarities which are confined to these two families. For the complete understanding of the significance of these points, a number of other organs will have to be taken into consideration; this the author promises to do.

Nervous System of Chætopterus Valencinii.*—M. J. Joyeux-Laffuie finds that it is not, as many writers have stated, difficult to dissect out the nervous system of *Chætopterus;* it is only necessary to keep specimens for some time in preserving fluids. In the median and lower regions the nervous centres are represented by a double ganglionic chain placed in the integument at the bottom of a groove formed by the two large ventral muscles. In each segment there are two symmetrical and fusiform ganglia, separated from one another in space, and connected by several very short commissures, the number of which is ordinarily seven or eight, but varies in different segments. Each ganglion gives off several nerves, three generally going to the neuropodium, and three, larger, to the notopodium.

In the superior region of the body the arrangements are very different. The connectives from the first pair of ganglia of the median region separate to form the two large nerve-cords; these cords are formed of two apposed bands, of which that which is ventrally placed is solely formed of nerve-cells, and the other of fibres with a few nerve-cells; the former represents the ganglia which appear to be wanting, and the latter the connectives; there are no isolated ganglia.

Contrary to what is usually stated, the author asserts that these cords give off on each side a number of nerves, and indeed, the superior region of the body of *Chætopterus* is that which is best supplied with nerves. The two cords are connected together by commissures. In addition to the optic and tentacular nerves already described as being given off from the dorsal part of the nerve-cords there are several others; of these the most important are the three pairs of buccal nerves which give the buccal infundibulum its great sensibility, and a pair of nerves distributed on the dorsal surface of either side of the vibratile groove.

The constitution of the apparently anomalous nervous system of the upper part of *Chætopterus* may be thus summed up; a dorsal and cerebroid part with nerves for the organs of sense, a ventral part formed of nerve-cells representing the ganglia, nerve-fibres which form connectives, and numerous commissures connecting the ganglionic parts.

Polygordius.†—Prof. J. Fraipont deals with the genus *Polygordius* in the 14th monograph of the Naples Station.

I. *Structure.*—After describing observations on the living worm, and the general external characters, he gives a detailed account of the anatomical and histological structure. The thick elastic cuticle, delicate near mouth, anus, tentacles, &c.; the subjacent hypodermis, thick and glandular in the cephalic lobe of the first segment and in the last, and with brick-red pigment in *P. neapolitanus;* the yellowish clear layer of longitudinal muscles; the subjacent irregularly thickened granular layer

* Comptes Rendus, cvi. (1888) pp. 148–516.

† Fauna und Flora des Golfes von Neapel, xiv. Monogr., 1887, pp. 1–127 (16 pls.).

with sparse orange or brick-red pigment, are all discussed at length. The yellowish or greenish moniliform digestive tube, its openings, and its ciliated interior; the body-cavity between the musculo-cutaneous wall and the gut; the vertical septa dividing the cavity and other oblique septa; the contained colourless fluid with pigment corpuscles and reproductive elements, then receive full attention. The lateral walls of each segment include a pair of ciliated horizontal canals, communicating with the body-cavity by a funnel on the anterior face of each septum. The vascular system consists of a dorsal, and of a ventral vessel, usually connected at each septum by a cross branch. The ventral vessel bifurcates in the cephalic segment, and unites with the dorsal. Caudally the two vessels end in culs-de-sac. In *P. neapolitanus* the lateral branches have vascular appendages. The blood is red in *P. lacteus*, green in *P. erythrophthalmus*, yellow in *P. neapolitanus*, uncoloured in one of Rajewski's species. The cephalic lobe of the first segment contains a central brain, which seems simple dorsally, but laterally is bilobed, and ventrally trilobed. The ventral median line bears a clear nerve-strand. The eyes are inconstant in the adults, and at best, rudimentary. Possible auditory organs, present in larvæ, do not persist. The oblique septa of each segment bear paired sexual organs. At maturity the contents fill the body-cavity. The sexes are separate. All these facts are described at length.

II. *Development.*—In the case of the female, at least (in *P. neapolitanus*, and *P. appendiculatus*, not in *P. villoti*), sexual maturity appears to be an end of the individual life; the ova are liberated by dehiscence. The appearance of the ripe ova is described. Artificial fertilization was effected, but the intimate processes were not observed. The segmentation is total, but unequal. From the stage with four cells, macro- and micromeres can be distinguished. It seems that the two primitive layers, epiblast and hypoblast, do not result respectively from the two first blastomeres. One of them, probably the epiblast, is formed at the expense of one of the two first spheres of segmentation, plus a certain number of elements successively arising from the other. The micromeres result in epiblast, the macromeres in hypoblast. The mesoblast arises from the hypoblast. The blastula phase is apparently succeeded by epibolic gastrulation, and the gastrula developes into a trochosphere larva. Some of the last conclusions are more or less hypothetical, but are confirmed by what is known of the development of *Protodrilus*.

After describing the external features of the larva of *P. neapolitanus* at successive stages, Fraipont proceeds to a detailed analysis of the various phases of larval metamorphosis. Starting from the trochosphere, he describes six distinct stages, and collates them with those described by previous investigators, and especially by Hatschek. The organogeny is resumed separately, that of the nervous system starting from (1) a central organ, the syncipital plate and the two lateral trunks from it; (2) the peripheral system, consisting of numerous nerves whose multiple terminations are associated with superficial epidermic cells; that of the alimentary system from stomodæum, mesenteron, and proctodæum; that of the body-cavity from the blastocœle; that of the mesoblast from two primordial mesoblast-cells arising from the hypoblast in front of the anus; and so on.

III. *Classification.*—After giving a brief history of our systematic

knowledge of *Polygordius*, Fraipont defines the genus as follows, in contrast to *Protodrilus*.

Archiannelids, relatively large.	Small size.
Mouth non-protrusible.	Muscular protractile pharynx.
Ring of pre-anal papillæ.	Two lateral posterior fixing lobes.
	Ventral longitudinal furrow.
Cilia in adult only in vibratile pits, and round the mouth.	Cilia in furrow, in the vibratile pits on the tentacles, and as rings on each segment.
Exceptionally scattered tufts of cilia.	
Unpaired, median ventral nerve-cord.	Two parallel and separate fibrillar nerve-cords.
Tentacles with one axial nerve-bundle.	Very mobile tentacles with vascular branches.
Vermiform movements.	Movements Turbellarian-like.
Separate sexes.	Generally hermaphrodite.
Development with metamorphosis.	No metamorphosis.
Polygordius lacteus Schneider; *P. apogon* M'Intosh; *P. villoti* Perrier; *P. erythrophthalmus* Giard; *P. neapolitanus* Fraipont; *P. appendiculatus* Fraipont.	*Protodrilus purpureus* Schneider; *P. flavocapitatus* Uljanin; *P. schneideri* Langerhans; *P. leuckartii* Hatschek.

IV. *Habitat.*—Prof. Fraipont then describes the habitat and mode of life of *Polygordius*, their sandy or fine gravel haunts, their contractile movements, their habit of fixing themselves by their posterior end, their great brittleness, their nutrition, sometimes apparently worm-like, in other cases discriminative. The females are usually larger than the males, they are (in some species) destroyed by their reproduction. The free surface life of the larvæ, their love for light when it is essential to their life, their nutrition of small pelagic animals, are then described.

V. *Geographical distribution.—Polygordius* has only been found as yet in European seas, at least in its adult state. Their occurrence in the North Sea, the Mediterranean, &c., is noted.

VI. *General conclusions.* — Professor Fraipont gives a welcome *résumé* of the various opinions held in regard to the position of *Polygordius*, and the morphological import of its larva. Believing it to be in the strict sense an Archiannelid, he discusses its relations with Ophelidæ, with *Protodrilus*, with *Histriodrilus*, and with *Dinophilus*. After a thorough discussion of the views held in regard to the larva, and an appreciation of the merits of each and all; after opposing especially the theory of Hatschek, Balfour, and Kleinenberg, who regard the larval characters as ancestral, to that of Lang and Sedgwick, who regard them as adaptive, Fraipont is forced to conclude in the cautious statement, that in the actual state of our knowledge, it is not yet possible to determine the morphological import of the larva of *Polygordius* or the trochosphere of Annelids, nor to draw from it any certain conclusions as to the phylogeny of the Annelida.

β. Nemathelminthes.

Spermatogenesis in Chætognatha.*—M. A. Bolles Lee has investigated the spermatogenesis of *Sagitta*. After some preliminary historical matter he proceeds to describe his results, which are thus (in abbreviated form) summarized.

As Hertwig has shown, the testes arise from the same primordial

* La Cellule, iv., n.d., pp. 107–33 (2 pls.).

cell which furnished the ovary for the same side. The solid mass includes "polyplasts," as in *Lumbricus*, with non-nucleated blastophore. These become free in the cœlom, and undergo complete segmentation. Their nuclei form distinct cells (spermatocytes) grouped round the blastophore. They multiply by karyokinesis, after the fashion described by Carnoy as "scission en anses parallèles," which is very different from Flemming's "heterotypical form." The spermatides, and the spermatocytes of certain generations, possess an accessory nuclear body ("Nebenkern"), with filamentous structure, and apparently arising in the nucleus.

Contrary to Grassi's statement, the sperms have a distinct head, formed from the nucleus of the spermatide. After the formation of the head, the nuclear caryoplasma seems to be restored to the cytoplasm, the nuclear membrane ceases to be distinct. The sperms have, (1) a procephalic filament, formed by a prolongation of the cytoplasm of the spermatide, (2) a tail consisting of an axial filament formed in the cytoplasm of the spermatide, (3) an undulatory membrane, forming a spiral round head and tail, and formed in the cytoplasm. The transverse striation, which has been described, is an optical illusion due to the spiral membrane.

The spermatozoa occupy in the polyplast a position opposite to that hitherto described in all polyplasts; the head is turned outwards, and the accessory nuclear body inwards, that is, towards the blastophore. The blastophore, or blastophores—for the primitive blastophore may become multiple by simple segmentation—may be absorbed during the development of the spermatides, or may persist, and be rejected from the polyplast at the end of spermatogenesis.

Life-history of Gordius.*—Sig. L. Camerano discusses the various species of *Gordius* found in Italy, and raises several questions in regard to their life-history. (1) *Are different species found in distinct hosts?* No, not necessarily. The filiform state is found exclusively in insects. The same species may occur in Arthropods and in fishes. (2) *Is man one of the hosts of Gordius?* Probably, in the larval stage. (3) *Is the development direct, or is more than one host requisite?* The life-cycle of *Gordius* is as follows:—(1) Egg, laid freely in water; (2) embryo, in water, within egg; (3) larva, (*a*) free in water for a time, (*b*) active or passive entrance into a host, (*c*) encystation; (4) metamorphosis, probably in the same host, the young stage with a filiform body, buccal aperture, segments and reproductive organs not yet developed; (5) adult, sexual, free life in water, where copulation and egg-laying occur.

Development and Specific Determination of Gordii.†—M. A. Villot has another note on this subject in answer to Dr. Camerano, in which he adduces evidence to support his claim to priority as to the methods to be adopted in determining the species of *Gordii*. He explains that, as the genital organs become developed before chitinization is complete, it is necessary to signify the stage reached by the worm under examination. M. Villot thinks he sees signs of Dr. Camerano not having fully studied his memoirs, and he refuses to accept as distinct certain forms regarded by Dr. Camerano as species, until the latter shall have been diagnosed by the taxonomic laws which he has formulated.

* Arch. Ital. Biol., ix. (1887) p. 59. † Zool. Anzeig., xi. (1888) pp. 70–2.

Natural History of Tylenchus.*—Dr. J. Ritzema Bos continues his report on *Tylenchus devastatrix* Kühn. (*a*) He discusses in the first place its influence on the plants which it infests. Though it never produces what can be called galls, it causes hypertrophy of the tissues of the plant. The hypertrophy seems to be due to some substance excreted by the parasite, but it is possible that the mechanical action of the mouth, &c., may also be a factor. That the former, however, is at least the main factor is suggested by a case of a *Tylenchus* found between, not in the leaves of *Hypnum cupressiforme*, and yet causing a hypertrophic abnormality. The author then notes the various degrees of plant disease caused by different species of *Tylenchus*, which multiply at different rates, &c. He thus contrasts *T. devastatrix* and *T. scandens*. The secreted substance is only fatal to the plant when large quantities are present.

(*b*) *Latent life.* The author cites some observations on the latent life of *T. scandens* (= *Anguillula tritici*). *T. devastatrix* seems to surpass the former in this capacity, which is saying a good deal. The experiments made by the author on ova, larvæ, and adults, are described at some length. Ova were kept dry for two months, and lived again on remoistening. Forms within the egg were similarly kept for six months. Larvæ remained latent for 2½ years, and might apparently have endured much longer. Sexually mature forms died in a few hours, and could not be resurrected. The age of the larva is an important element in such experiments. The period required for reawakening varies greatly. The temperature of the water used in reviving is likewise important; raised temperature assists the process. The desiccation may be repeated many times; the author repeated it sixteen times in succession; each time a longer period was required for revivification; and after the sixteenth experiment none survived. The process is thus by no means indefinite. The advantage of this power for the species is discussed. Not desiccation alone, but cold also may cause latent life. Some were cooled down to − 19° C., and when the plant in which the worms were, was slowly warmed up again, the *Tylenchi* larvæ revived. If the reheating was sudden, none survived. The cessation of life-activity and the revivification is explained by reference to vital ferments. Lastly, the author notes how putrid substances, of plant or animal origin, or the presence of rotting neighbour *Tylenchi* may produce the same latent vitality.

γ. Platyhelminthes.

Tænia nana.†—M. R. Moniez is not inclined to accept without discussion some of the recent results of Prof. Grassi regarding *Tænia nana.*‡ He cannot admit that *Cysticercus tenebrionis* belongs to that tapeworm, owing to the differences in their spines; *C. tenebrionis* appears rather to be the cystic stage of the *T. microstoma* of the mouse.

T. murina appears to M. Moniez to be a distinct species from *T. nana*, for the former is nearly twice the length of the latter, and their embryos are altogether different in form; moreover, *T. murina* may be found in localities from which *T. nana* is altogether absent.

Some European Triclades.§—Dr. I. Ijima has notes on various European Planarians, among which *Planaria abscissa* is a new species,

* Biol. Centralbl., vii. (1888) pp. 646–59.
† Comptes Rendus, cvi. (1888) pp. 368–70. ‡ This Journal, 1887, p. 961.
§ Journ. College of Science, Imp. Univ. Japan, i. (1887) pp. 337–58 (1 pl.).

found in Thuringia. In all individuals of this species cilia may be distinctly made out over the whole of the body; at various points are groups of stiff setæ three or four times as long as the ordinary cilia, and to such Lang has correctly ascribed sensibility. The excretory canals at the anterior end of the body are very distinctly seen, owing to the slight development of pigment, and the absence of other opaque organs; the lateral primary canals are much coiled, and lie above the intestine; they pass forwards externally to the eyes, and soon unite with one another, just as in *Dendrocælum lacteum;* a number of the elongated ciliated funnels are set alone on the finer branches of the system. The author is of opinion that *P. ulvæ* Oersted should be placed in the genus *Gunda*, and the arrangement of its generative organs agrees exactly with what is seen in *G. segmentata* Lang. The penis of *P. abscissa* is much smaller than in other species, and there is no swelling on the course of its duct; between the lining epithelium and the external muscular fibres there are circular muscles; the great development of the muscles in the wall of the penial sheath may be correlated with the absence of a portion formed of coiled fibres, which is of great importance in the ejaculation of the sperm.

In *P. torva* the numerous testes are arranged in two layers, above and below the enteric branches, just as the author has described them in *Dendrocœlum lacteum;* in the other species examined they are in one layer, dorsal in *P. gonocephala*, *P. polychroa*, and *Gunda ulvæ;* in *P. abscissa* they are ventral in position.

In *P. torva* and *P. abscissa* the two oviducts unite, above the penial sheath, into a common duct which opens, in the former, above the top of the penis, and in the latter, just internally to the opening of the penial sheath. In *P. gonocephala*, as in *P. polychroa*, each oviduct opens separately into the terminal part of the uterine duct; the unpaired duct of *G. ulvæ* opens at the same point.

In addition to the two ventral longitudinal nerves there are two much more delicate lateral nerves; these arise a short distance in front of the eyes, and it may, therefore, be supposed that they do not take their origin directly from the brain. Like the ventral nerves, they are not only connected with one another by finer branches, but they give off laterally plexus-forming nerves, which probably become connected with the ventro-lateral nerves at the margin of the body, and so complete a nervous tube, such as has been described by Gaffron in *Distomum isostomum*. In *P. abscissa* and *G. ulvæ* Dr. Ijima has been able to see the so-called marginal nerve discovered by Lang. The stepladder-like transverse commissures of the peripheral nervous system of *P. gonocephala* make so many branchings and crossings, that it was scarcely possible to determine their number; in *P. torva* and *P. abscissa* they are much less numerous, and yet there are more than forty of them.

The central lobes of the two just mentioned species are distinguished from those of *Dendrocœlum* or *Polycelis* by the fact that each is traversed in the dorsoventral direction by a large column of ganglionic cells and muscular bands, with which a small amount of connective tissue may be connected. It may be regarded as an arrangement by which a number of ganglionic cells are brought into closer connection with the inner portions of the lateral parts of the brain. The brains of these Planarians are also distinguished by the backward and lateral course of the lateral

margins of the lobes; by this arrangement the point of origin of the sensory nerves thence given off is somewhat increased in extent.

The brain of *Gunda ulvæ* differs in some points from that of *C. segmentata*. Thus, it has three, not four, sensory nerves on either side, and the optic nerve is the most delicate of all; the minute structure of the brain of this worm is described in some detail. The greater part of the longitudinal nerves take part in forming the brain, but a small ventral portion is continued further forwards, and is separated from the base of the brain by a space beset with ganglionic cells, and there is thus formed the nerve which is ordinarily spoken of as the anterior longitudinal nerve; this is the chief point in which the brain of *Gunda* differs from that of other fresh-water Triclades with bilobed brains, for in them the hinder longitudinal nerve-trunk completely fuses with the base of the brain.

δ. Incertæ Sedis.

Floscularia annulata.*—Mr. J. Hood describes a new species of *Floscularia* which he has found in Fifeshire and Perthshire. The corona is a hemispherical cup, the edge of which is cut into three lobes of unequal size; these not only differ in form from those of *F. hoodii* and *F. trilobata*, but also in the fact that the tips of the lobes only are crowned with short setæ, whereas in the other two species there are double rows of setæ running round the whole margin of the corona. Examined as a transparent object, *F. annulata* appears to have three brown rings below the corona; seen as an opaque object, these are white. The jaws at the entrance to the stomach have an upward motion, and at the same time they open out to seize the food and drag it into the stomach. Sometimes the jaws close on the spherical body of a monad a little below its centre, and "when it so happens that the jaws fail to clutch it, the spherical body rebounds back into the cup, just as a person grasping at an indiarubber ball with finger and thumb just below the centre produces the same result. This rebound shows the toughness and elasticity of the cuticula of these minute monads." Full-grown specimens of *F. annulata*, the female of which is alone known as yet, are from 1/64 to 1/50 in. in length.

Nervous System of Myzostoma.†—Dr. F. Nansen gives an account of the anatomy and histology of the nervous system of several species of *Myzostoma*, and concludes with some generalizations which are more fully treated of in his report to the Bergen Museum.

The central nervous system of *Myzostoma* consists of an œsophageal ring, with which ganglia or ganglionic cell-masses are connected, and a short ventral cord with no distinct ventral ganglia, but with indications of segmentation; in connection with the ring there is a spirally developed complex of nerves in the proboscis, which has never before been detected by any observer. From the œsophageal ring these nerves pass forwards on either side towards the tip of the proboscis, and connect the ring with another—the tentacular nerve-ring, which, though variously developed in different species, has always considerable dimensions; it is surrounded by a thin sheath, within which there are no ganglionic cells; in *M. Graffi*, however, the ring is surrounded by a number of cells, which

* Science-Gossip, 1888, pp. 8–10.

† Jenaisch. Zeitschr. f. Naturwiss., xxi. (1887) pp. 267–321 (1 pl.).

are unipolar, and are connected with the ring by their processes. The tentacular nerve-ring gives off a nerve for each tentacle, and these, at the tips, are broken up into a tuft of fibrils. The epithelium of the tips appears to consist only of long fibrillar cells, with which it is probable that the separate nerve-fibres are connected. Four more interesting and important nerves go to the hinder end of the proboscis, then bend round the hinder end of the bulbus musculosus, and pass forwards towards the œsophageal ring. Below the œsophageal epithelium these four nerves form a kind of plexus, from which a number of small nerves are given off. Between the epithelial cells there are a number of ganglionic cells which are often seen to be in direct communication with the nerve-trunks; and the epithelial cells themselves, which are very elongated and provided with long nuclei, are connected by long processes with the fibrils given off from the nervous branches; this epithelium may be supposed to have a gustatory function. The author's account of the peripheral nervous system is, unfortunately, in the form of a description of his figures, and without them is unintelligible.

The nervous system is invested in an outer firmer sheath—the outer neurilemma or perineurium, and an inner supporting substance or internal neurilemma. The general discussion of the histological characters of the central nervous system of animals is a partial statement of the views in the author's fuller essay (for which see above).

Echinodermata.

Development of Antedon rosacea.*—Mr. H. Bury has investigated the early stages in the development of *Antedon rosacea*.

(1) *External Form.* The segmentation is regular, the gastrula by invagination, the blastopore closes early, ciliation is at first uniform, but differentiates into anterior tuft and five ciliated bands, the anterior band is incomplete ventrally. There are two ciliated ventral depressions—the "preoral pit" and the "larval mouth." The yellow cells appear before the rupture of the vitelline membrane. The free larva swims with terminal tuft forwards. A white patch on the left between the third and fourth bands marks the position of the "water-pore."

(2) *Internal Anatomy.* A mesoderm is budded off from the archenteron. The blastopore closes near the posterior end. The archenteron, occupying the posterior half of the larva, divides into posterior dumb-bell-shaped enterocœle, round the constricted part of which the anterior half (mesenteron) grows to form a complete ring. The two swellings of the dumbbell form the right and left body-cavities. The anterior part of the mesenteron buds off the (left and ventral) hydrocœle and an unpaired anterior body-cavity. The left body-cavity becomes anterior and dorsal, the latter sends a five-chambered prolongation into the preoral lobe to form rudiment of "chambered organ." The hydrocœle forms a ring, incomplete to the left, on ventral side of mesenteron, and forms five ventral pouches. Just before fixing, the anterior body-cavity opens at water-pore. Fine lateral nerve-fibres below anterior tuft, preoral pit, and down the sides of larval mouth disappear with loss of freedom.

(3) *Fixing.* After twenty-four hours' swimming the larva fixes by preoral pit; the bands disappear; the mouth invaginates to form vestibule, which, as Barrois describes, is rotated to posterior end. Histolysis

* Proc. Roy. Soc., xliii. (1887) pp. 297–9.

sets in, cells budded in from the centre of the hydrocœle fill the mesenteron. The right and left body-cavities, now dorsal, grow round original ventral side, and each forms a longitudinal mesentery near the original ventral radius. The mouth appears as a depression in the wall of the vestibule. Into the now small anterior body-cavity opens the stone-canal, running from the water-vascular ring in the oral longitudinal mesentery, and not in direct continuity with the water-pore. The anus opens in the same interradius as the water-pore.

(4) *Skeleton.* Shortly after the disappearance of orals and basals, three plates are developed at the posterior end of the stem, the homologues of the under-basals of the dicyclic Crinoids. After fixing they fuse with one another and with the top-stem-joint, so as to form a large plate, hitherto mistaken for a simple centrodorsal.

New Features in Pelanechinus corallinus.*—The most interesting point, perhaps, in Mr. T. T. Groom's account of *Pelanechinus corallinus* is the discovery of pedicellariæ in a fossil species; the author has found them "in great variety and abundance, and in beautiful preservation." The only good mode of examining them is to put the whole urchin on the stage of the compound Microscope and to illuminate it well; if this method were adopted, Mr. Groom believes that pedicellariæ would be often found on fossils. In *Pelanechinus* all these organs are trivalved, and of these three distinct varieties were found, which are described and figured.

Budding in Star-fishes.†—Herren P. and F. Sarasin give a figure of a specimen of *Linckia multipora*, in which the process of regeneration has resulted in the formation of a quite new star; in this case we have to do with two stars connected with one another, and so giving the appearance of a true animal colony. But they allow that these colonial formations are to be regarded as abnormalities. However, there is no sharp limit between pathology and variability, and so facts of this kind are always of significance. Fuller details are promised.

Mediterranean Synaptidæ.‡—Dr. R. Semon continues his account of the Synaptidæ of the Mediterranean. The calcareous ring commences to be formed at a time when the rudiment of the water-vessel in the *Auricularia*-larva consists of a horseshoe-shaped tube with the outgrowths which will form cæca, primary tentacles, and radial vessels; they arise as simple rods on the convex side of the tube, and, in correspondence with the number of tentacles, there are at first only five; we see then the relations which they have to the tentacles. This is further shown by the fact that the joints of the calcareous ring increase in number simultaneously with the tentacles. These facts bear on the question of the homology of the calcareous ring with some of the hard parts of the Echinoidea. Dr. Semon thinks that before we proceed to speculate on this point we must get some proof of a skeletal part of an Echinid holding the same relation to the five primary tentacles as do the parts in question in a Holothurian. The ring not only serves as origin for the tentacles—which appears to be its primary function—but also for the insertion of the semilunar valves described by Hamann. When the longitudinal musculature of the tentacle is relaxed that organ lies extended in a straight line, and the valve (in consequence of the

* Quart. Journ. Geol. Soc. Lond., xliii. (1887) pp. 703–14 (1 pl.).
† Zool. Anzeig., x. (1887) pp. 674–5.
‡ MT. Zool. Stat. Neapel, vii. (1887) pp. 401–22 (1 pl.).

contraction of its musculature) is open; there is no obstacle to the free passage of fluid backwards and forwards. The retraction of the tentacle is effected by the contraction of the whole longitudinal musculature; and the tentacles are then so bent that the valve becomes closed.

The author's account of the central nervous system does not agree in all points with that of Hamann; he denies the justice of the opinion that the peripheral cells are not nervous, and, though allowing the impossibility of at present making a definite judgment, he is inclined to think that they are nervous, and not merely supporting.

With regard to the vesicles of Baur, Dr. Semon objects to the view that they are merely larval organs with no function in the adult, and urges that they increase in size with the growth of the individual. In their morphological characters they agree with the auditory organs of all other animals than insects. Each organ is a saccule or vesicle formed by an ectodermal invagination, in the fluid contents of which there are more or less freely moving bodies.

The remarkable ciliated funnels of the cœlom, which were described by Johannes Müller, have been but little investigated since 1852 to any good purpose. In structure the true ciliated organ is very simple, consisting of a curved plate provided at its margin with a projecting ridge; this last is really nothing else than the margin of the plate which has been bent over; like the plate it consists of long, rather thin cylindrical cells, the elongated nuclei of which are proportionately very large. Each cell appears to carry only one very long cilium, but on this point it is impossible to be confident. The long axes of all the cells are directed towards the centre of the funnel, and this gives rise to very different appearances with different focal points. The organ does not seem to be a real funnel which passes into a closed tube, for the infundibular portion leads into a curved groove open on one side. This groove opens into the sac of the peritoneal membrane, which invests the outer side of the organ, and is continuous with the stalk. This investment consists of flat spindle-shaped cells, each with an elongated nucleus. The muscular fibres of the peritoneum are not continued into the stalk, nor could the author find there any nerve-fibres. The stalk is not hollow, and does not inclose any canal. Though there is no true lumen there are a large number of cells in the clefts in the stalk, which completely resemble the cells which are found in the fluid contents of the cœlom. These are the bodies which Semper called mucous cells, and Hamann, more appropriately, plasmatic wandering cells. They are distinguished from the so-called blood-cells by the very distinct granulation of their protoplasm, that of the blood-cells being clear and not granulated. The suggestion is made that the ciliated funnels have the function of taking up the lymphoid cells which swim about freely in the cœlom, and conveying them to the tissues; at the orifice of the funnel there are often masses of cells. Dr. Semon does not think that the ciliated funnels are true excretory organs. When the stalk is attached to the peritoneum its tissue is continuous with that of the peritoneal epithelium. The author is of opinion that we may regard the funnels as large and complicated lymph-stomata of the cœlom, and suggests that the cells have wandered from the enteric blood-vessels into that cavity. A direct connection between this vascular system and the cœlom has not been made out, and it may be that its place is taken by the wandering of lymph-cells through the tissue.

Cœlenterata.

Cladonemidæ.*—Dr. C. Hartlaub believes that the Cladonemidæ are one of the most interesting families of the Craspedota. The relations which they exhibit to the Ctenophora support the views of Haeckel and Chun. The rarity of these forms may be partly explained by the slight development of the gonads of the Medusa stage. And indeed sexual reproduction in *Eleutheria* is quite inconsiderable as compared with multiplication by budding.

The following classification of the group is proposed :—

Family Cladonemidæ Haeckel.

First sub-family, Eleutheridæ, with an apical cavity,	*Eleutheria.* *Pteronema.* *Ctenaria.* *Dendronema.*
Second sub-family, Cladonemidæ,† sens. str. No apical cavity,	*Cladonema.* *Zanclea.* *Gemmaria.*

They may be defined as having the manubrium with five edges, with five perradial mouth-styles, and five perradial evaginations of the gonads; there are five radial canals, three of which divide, so that eight canals of the second order open into the circular canal; there are eight tentacles.

The manubrium of *Cladonema* has the form of a more or less well-marked prism, the edges of which are perradial or lie in the planes of the five radial canals of the first order; the central stomach may be distinguished from a more well-developed oral tube; the former alone takes part in the development of the sexual products, and the stomach is, as in the Codonidæ, surrounded by a continuous gonad. The five edges of the manubrium correspond in position to five endodermal longitudinal ridges which project into the lumen of the gastric cavity, and leave between them five perradial grooves, which, at the proximal end of the organ, pass into the five radial canals.

The endoderm of the mouth-tube has some interesting histological peculiarities; at the mouth there are gland-cells consisting of finely granular protoplasm, but, further in, the cells are almost all cnidoblasts; a large quantity of stinging cells, it may be observed, have also been observed in the endoderm of the planula of *Eleutheria*.

Cladonema is hermaphrodite, but the hermaphroditism is successive; at the same time there is no rule as to which several products shall first appear. Several young egg-cells of considerable size may fuse into one; the gonads are always traversed by high supporting cells of the ectoderm; the spermatoblasts and the egg-cells, which are often found lying among them, are only distinguished by their size. In the endoderm of the gastric cavity there are to be found among the ordinary nutrient cells deeply coloured bodies filled with more deeply coloured spheres. Between the spheres it is often possible to make out distinct cell-boundaries; these bodies have a close resemblance to germ-cells.

* Zool. Anzeig., x. (1887) pp. 651–8.

† Had the author followed the conventions of the British Association he would have written Cladonemine, and so saved possibilities of confusion.

Occasionally indubitable egg-cells are to be found in the endoderm. The sexual cells of the Cladonemidæ appear to be developed, in all cases, in the endoderm. If the continuation of the author's studies shall confirm this generalization, we have here a further point of agreement with the Ctenophora.

Hydra.*—Prof. J. Leidy thinks that Prof. L. Agassiz was wrong in naming the two American species of *Hydra*, *H. gracilis* and *H. carnea*, as they do not seem to be really distinct from the European *H. viridis* and *H. fusca*.

Are there Deep-Sea Medusæ?†—Mr. J. W. Fewkes discusses the difficult question of the bathymetrical distribution of Medusæ. He notes (1) the two wholesale methods of dredging, which leave the actual depth of habitat often very hypothetical, the negative results as yet obtained by the use of a contrivance like Sigsbee's "gravitating trap," and the unsatisfactoriness of actual records. (2) He approaches the subject from another side, and suggests the study of characteristics of structure in relation to probable environment. In illustration of this, the Siphonophore genus *Rhizophysa*, and the Acraspedan Collaspidæ (*Atolla*, *Collaspis*, *Nauphantopsis*), are discussed. These three last genera present us the strongest arguments which can be found in the modification of external and internal anatomy, as indicative of a deep-sea habitat. In the same way he draws conclusions from Lucernarida. But Mr. Fewkes is forced to confess that neither the data so far gathered, nor the recorded depths, nor the structure of the genera considered, demonstrate that there is a serial distribution of free medusæ in bathymetrical zones. For all that he concludes that the case for the affirmative is stronger than the arguments suggest.

Sex-cells and Development of Millepora.‡ — Mr. S. J. Hickson communicates his observations on the sexual cells and the early stages of development of *Millepora plicata* found abundantly on the fringing reefs of Talisse Island, N. Celebes. (*a*) The young sex-cells arise in ectoderm of cœnosarcal canals, perforate the mesoglœa, and enter the endoderm. The ovum is moored to the mesoglœa by a pseudopodial stalk, or may withdraw this and migrate. (*b*) Before maturation the germinal vesicle disappears, a longitudinally striated spindle-shaped body appears, and gives off the first polar globule. A second does likewise. The mature ova, with yolk-globules or granules, measure only 1/100 mm. in diameter. (*c*) Two or three sperm-heads may be seen within one ovum, the flagella stuck at the surface. The nucleus is again visible after fertilization, subsequently with a number of nucleoli. (*d*) The nucleus fragments, the portions are scattered in the pole nearest stalk; they travel to form an equatorial zone in middle of ovum; the zone divides, and the halves, with their fragments increasing in number, size, and distribution, move towards the poles. The result corresponds to a morula; faint markings indicate cell-outlines. (*e*) As a solid blastosphere, the embryo migrates into gastrozooid, and probably passes out by mouth. There was no trace of medusa, medusiform gonophore, or sporosac.

The young male cells or spermospores have a large nucleus with

* Proc. Acad. Nat. Sci. Philad., 1887, pp. 311–3.
† Amer. Journ. Sci., xxxv. (1888) pp. 166–79.
‡ Proc. Roy. Soc., xliii. (1887) pp. 245–7.

coarse network; the nucleus fragments and the fragments spread. The spermospores matured in the canals migrate to basal endoderm of dactylozooids, lose their walls, pass as colonies of young spermoblasts into cavity of zooid, push out the wall into sporosacs and rest there till mature. Occasionally they were found in gastrozooids.

The ectodermic origin of sex-cells (Hertwigs and Weismann) is confirmed. The absence of segmentation and sperm morula may be associated with migration after commencement of development. There is no corroboration of the suggestion that the *Millepora* have lost their yolk. The Hydrocorallinæ are probably a separate stock, never with medusiform gonophores, and without any relation to *Hydractinia*.

Structure and Affinities of Parkeria.* — Prof. H. A. Nicholson thinks that Mr. H. J. Carter was right in referring the genus *Parkeria* to the Hydrozoa. All the known facts as to the chemical constitution, mode of growth, and general structure of the cœnosteum, no less than the minute structure of the skeleton-fibre, seem to him to point in this direction. The genus may be regarded as intermediate between the Hydrocorallines and the Hydractiniidæ; it resembles the former more closely in the minute structure of the skeletal tissue, and the latter in the mode of growth by the production of successive concentric lamellæ separated by rows of chamberlets. With regard to its supposed allies among fossil forms, the author states that *Syringosphæra* differs in not increasing by the formation of successive concentric lamellæ with intervening rows of chamberlets, and that that genus is a true Hydrocoralline; *Porosphæra* is probably a Lithistid sponge; the resemblances between *Parkeria* and *Loftusia* are merely superficial; there are unquestionable points of resemblance and marked points of difference between *Parkeria* and the groups of Stromatoporoids.

Growth of Flabellum.†—Dr. E. von Marenzeller finds that in the genus *Flabellum* the new septa arise between the older ones, as in other stony corals. In some species this is effected regularly, but in others the chambers at the end of the long axis are specially numerous; and in them septa of higher orders appear before those of the next lower order have been developed in other chambers. In a few species the septa retain their relative sizes, but in most those of the second and third order grow as large as those of the first; this happens particularly in those species in which the development of the septa of the higher orders is irregular. The equalized septa ordinarily have between them three septa, two of the last and one of the penultimate order, and they thus give rise to that division into polyparies, which is so characteristic of the genus. In addition to notes on known forms, there is a description of *F. coalitum* sp. n. from Japan.

Classification of Alcyonaria.‡—Prof. T. Studer, who has, in conjunction with Prof. E. P. Wright, studied the Alcyonacea of the 'Challenger' Expedition, has an essay on the classification of the order. This is a matter of some difficulty as the palæontological history can never be completely known, owing to the fact that we can never know the structure of the polyps. In all Alcyonaria, with the exception of the small family Haimeidæ, which perhaps represent the primitive form,

* Ann. and Mag. Nat. Hist., i. (1888) pp. 1–12 (1 pl.).
† Zool. Jahrb., iii. (1887) pp. 25–50.
‡ Arch. f. Naturgesch., liii. (1887) pp. 1–74 (1 pl.).

there is a tendency to form colonies by budding; these buds, however, never arise directly from the body of the polyps, but from stolons which are tubular outgrowths of the digestive cavity of the polyps; the highest development is probably that in which a large number of individuals are so distributed that each has an equal share in the nourishment; this is best seen in the upright arborescent stocks, where the individuals are spirally disposed. But such a colony is only possible if a supporting skeleton be differentiated; representatives of this type are to be found in the Gorgonacea.

The simplest form of colony formation appears to be that in which the stem-polyps give off tubular processes which are outpushings of the body, and the cavities of which are continuations of the digestive cavity of the polyps. On these stolons new polyps arise by budding, and these, again, may produce polyp-forming stolons; such are found in *Rhizoxenia*, *Cornularia*, and some species of *Clavularia*. A more compact colony is formed when the base of the polyps, in which the mesoderm is considerably developed, broadens out around the polyp, and contains endodermal tubes from which new polyps arise by gemmation; they are seen in *Clavularia rosea* and *C. violacea*. In these forms the cœnenchym is a thin membrane, but it may become better developed, so that the deeper part of the elongated digestive cavities lie in it, as in *Anthelia*, *Sarcodictyum*, and others.

The colony may become raised up from its base, and differentiated spicules be developed to form a supporting axis; this is seen in the lower Briareidæ, such as *Solenocaulon;* in the higher types the axis is more developed, passes into the interior of the colony, and forms a cylindrical rod, which is surrounded by polyp-bearing cœnenchym, as in the division Scleraxonia, of which the highest type is *Corallium*. In another series of forms, the most favourable arrangement of the individuals is effected in another way; bundles of polyps, the walls of which have thickened into a common mass of cœnenchym, grow out into long tubes, and develope new polyps at various levels; thus we get lobed forms as in *Alcyonium* and *Lobularia*, or tuft-like growths such as in the Nephthyidæ. Lastly, there are trunk-polyps whose cœnenchym walls are traversed by canals, and which give off long tubes; in the walls of the axial polyp, small long tubular polyps are budded off, and these again may give rise to small lateral polyps as in *Tolesto* among the Cornulariidæ. As the hollow axial polyp cannot form sufficient support for the development of a broad stock, a solid horny or calcareous mass is developed in the long digestive cavity; this gradually gives rise to the central axis of the colony, while the lateral mesenterial septa become the vegetative longitudinal canals of the colony, and the mouth and tentacles of the axial individual disappear. These often exhibit a bilateral symmetry. The Pennatulacea do not form fixed colonies as do the Holaxonia (or Axifera).

The author next points out the modifications undergone by the spicules, and the differentiations which affect the polyps.

The three divisions of the Alcyonaria—Alcyonacea, Pennatulacea, and Gorgonacea—proposed by earlier writers, are accepted, the last being divided into the Scleraxonia and Holaxonia.

In the systematic lists which follow, the relations of the genera are indicated, and there are notes on some of them; the various families are defined. Novel points, in addition to the delimitations of the Scleraxonia

and the Holaxonia, are the establishment of a new family of Dasygorgidæ (owing to the discovery of some new species of *Dasygorgia*, and of a new genus, *Strophogorgia*, with an unbranched stem), of a new sub-family, Primnoisidinæ, of which *Primnoisis* is new, and of two sub-families, Callozostrinæ for Prof. Wright's new genus *Callozostron*, and Primnoeidinæ for *Primnoeides* g. n. Among the Muriceidæ, *Muriceides*, *Anthomuricea*, *Clematissus*, *Placogorgia*, *Perisceles*, and *Elasma* are new.

Norse Alcyonaria.* — Herr J. A. Grieg describes and figures a number of new Norse Alcyonaria:—*Sympodium hyalinum* n. sp., *Stenogorgia rosea* n. sp., *Danielssenia* n. g., *D. irramosa* n. sp., *Paramuricea elegans* n. sp., *Protoptilum tortum* n. sp., *Stichoptilum* n. g., *S. arcticum* n. sp. The new genus *Danielssenia* includes corals of Kölliker's *Gorgonia* genus. The trunk is branchless; the base expanded, adherent; the polyps in single series on each side of trunk; the polyp-cells low, broad, basally expanded, partly embracing the smooth, round, horny axis; comparatively thick sarcosoma; œsophagus and gastral filaments without spicules; the centre coral otherwise abounding in spindles, clubs, and double-stars. The new genus *Stichoptilum* includes sea-pens of Kölliker's family Protoptilidæ. The polyp-cells are sessile, on each side of rachis in two single rows, the outer with full-grown, the inner with rudimentary polyps; the cells cylindrical with eight inconspicuous spines, the zooids small, in three single rows, an inner row in the dorsal mid-line, the outer rows on each side of round rachis, calcareous bodies in stalk, rachis, cells, and tentacles. The memoir is accompanied with some beautiful figures.

Porifera.

So-called Peripheral Prolongations of Clionæ.†—M. E. Topsent has some remarks on the theory of Herr Nassonow, that the filaments found in shells or stones perforated by *Cliona* are prolongations of the mesoderm of *C. stationis*. He finds that these filaments may be wanting in shells attacked by *Cliona* during the life of the mollusc, and that they are abundant in all old imperforate shells. Regarded as independent of the sponge, they have often been studied and figured. M. Topsent has recently found them in the valves of *Unio*, and there seems to be no doubt that they are parasitic plants.

Structure of Suberites.‡—Mr. J. Arthur Thomson describes the histology of *Suberites domuncula* Olivi (O. S.). After noting the general relations of the sponge to the mollusc shell on which it grows, he describes the ectoderm and small pores, the uniaxial spicules, the ciliated chambers disposed in Vosmaer's fourth degree of complexity, the afferent and efferent canals lying side by side, the multiform connective tissue of the mesoderm, the incipient muscle-cells, and the like. The presence of developing sperm morulæ and ova is also noticed. Special attention is directed to the very varied chromatic contents of the germinal vesicle, which appears to be either multinucleolar, or to have a nucleolus of very complicated shape.

(2) The author also describes peculiar knob-like capsules formed on

* Bergens Mus. Aarsberetning for 1886 (1887) pp. 1–26 (9 pls.).
† Comptes Rendus, cv. (1887) p. 1188.
‡ Trans. Roy. Soc. Edin., xxxiii. (1887) pp. 241–5 (2 pls.).

the surface of a *Spongelia* in disadvantageous circumstances. They contained incipient tissue with undifferentiated cells, and had on section the appearance of a very intricate network. It is suggested that they secure the persistence of the organism in unfavourable environment.

Protozoa.

Digestion in Rhizopods.*—Miss M. Greenwood has continued her observations on the digestive processes in *Amœba* and *Actinosphærium* with the following results:—

(1) The ingestion of solid matter is promiscuous in *Amœba*, that is, nutritious and innutritious matters are taken in with equal readiness. *Actinosphærium*, on the other hand, rarely ingests innutritious particles. (2) The act of ingestion in *Amœba* is accompanied by the emission of pseudopodia; in *Actinosphærium* these may or may not be thrown out. (3) The nutritious matter taken in by *Amœba* is not surrounded by fluid when it lies in the endosarc. (4) Nutritious particles are in both animals digested by fluid poured out around them. This fluid has no action on the cuticle of organisms, or on cellulose or siliceous cell-walls. Fat and starch are apparently not digested by it. It is a colourless fluid, which acts on coagulated, and still more so on non-coagulated proteïd matter. It has no action on litmus or carmine particles, accidentally inclosed with nutritious particles, and is therefore neutral in reaction. (5) The secretion is more active in *Actinosphærium* than in *Amœba*. (6) Chlorophyll is changed to a dark-brown colour by *Amœba*; this is not so marked in *Actinosphærium*. (7) Ejection is performed at the hind end of *Amœba*, either by means of a vacuole, or often without one. An excretory vacuole is always present in *Actinosphærium*. (8) The time between ingestion and ejection is difficult to determine, and varies with the size and digestibility of the ingesta; it averages three to four days in *Amœba*. In *Actinosphærium* the digestive act is shorter, and occupies from 1½ to 8 hours.

Protozoa Parasitic in Man.†—Prof. B. Grassi emphasizes the innocuous or purely commensal character of Protozoa found in man. He discusses *Amœba coli*, mono-cercomonads, *Megastoma* (Flagellate), *Balantidium coli*, and disputes the Protozoan nature of Pfeiffer's Monocystis and of *Plasmodium malariæ*.

Psorospermium Haeckeli.‡—Dr. O. Zacharias has found the sporozoon first noticed by Haeckel in the crayfish, in Silesian and Galician specimens; those that were examined seem to be quite healthy. The parasites are of an elongated oval form, and are sharply separated from the tissue of their host by a firm cuticle; the long diameter is about 0·18 mm., and the breadth from 0·04–0·05. Several thousand may be found in one crayfish, and it is not improbable that, if they increase too rapidly, they may give rise to epidemics. They are much more common in old than young individuals. When present they may be easily detected in the eye, and it is likely that this is their way of entrance into the body of their host. Dr. Zacharias has, however, been able to show that the psorosperm is capable of multiplying within the body of

* Journ. of Physiol., viii. (1887) pp. 263-87. Cf. Journ. Chem. Soc. Lond., 1888, Abstr., p. 79.

† Arch. Ital. Biol., ix. (1887) pp. 4–6.

‡ Zool. Anzeig., xi. (1888) pp. 49–51.

its host. The reproductive bodies are in the form of spheres, which escape from the mother organism and wander into the neighbouring tissues.

Eozoon Canadense.*—Sir J. W. Dawson gives some new facts regarding *Eozoon Canadense*. Though the form of this body is ordinarily regarded as indefinite, well-preserved specimens show that the normal shape of young and isolated examples is a broadly turbinate, funnel-shaped, or top-shaped form, with sometimes a depression on the upper surface. Other forms are rounded or dome-shaped masses. In sections more or less cylindrical depressions or tubes may be seen. If *Eozoon* was an organism growing on the sea-bottom, it would be liable to be broken up, and in this condition to constitute a calcareous sand or gravel; examination of Laurentian limestones frequently reveals the presence of *Eozoon*. *Cryptozoum*, whatever be its zoological relations, is found in Cambrian rocks under the same conditions as *Eozoon* in the Laurentian. The mistakes made by some lithologists are due to the remarkable imitative forms of gneiss, laminated limestone with serpentine, and various other laminated or banded materials which are often found in collections or specimens of *Eozoon*. As to these, Sir J. W. Dawson promises further details. In a postscript the objections to the suggestion of Julien and others that eozoonal structure may be due to the alternation of mineral layers formed in the passage-beds between concretions and their inclosing mass are summarized.

* Geol. Mag., v. (1888) pp. 49–54 (1 pl.). Cf. also Rep. Brit. Assoc. Adv. Sci., 1887 (1888) p. 702.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.*

(1) Cell-structure and Protoplasm.

Influence of Light upon Protoplasmic Movement.†—Mr. S. Le M. Moore has further investigated the phenomenon that chlorophyll-grains alter their position, collecting into masses in sunlight, and moving on to the side-walls of the cells, the latter movement being effected also, but more slowly, in darkness. These displacements of chlorophyll are the effect of illumination and not of heat. Frank gave the name of "epistrophe" to the distribution of the grains upon the free walls and the parts of the wall bordering on intercellular spaces, and that of "apostrophe" to the arrangement upon the side-walls. He also confirmed the statements of his predecessors that epistrophe is more quickly assumed after apostrophe than *vice versâ*. Apostrophe produced by strong illumination Moore proposes to call "positive," that produced by weak illumination "negative."

To the whole of these phenomena Mr. Moore applies the term "photolysis," and proceeds to discuss the question whether the grains of chlorophyll are drawn passively along with the streaming plasma, or whether they have the faculty of independent motion. The question was answered in the former sense by Sachs, and Frank and Pfeffer are of the same opinion. On the other hand, Prillieux looks upon the movement as resulting from the attraction of one grain upon another, and of the cell-wall upon the grains. Velten considered that the grains have some power of moving independently of the protoplasm.

The author gives three reasons which have led him to declare in favour of Sachs's theory. As to the movements of chlorophyll-grains in the dark, the results obtained under this head are thus summed up:—(1) The epistrophized grains of sun-loving plants are negatively apostrophized after a few hours in darkness. (2) Negative apostrophe is very slow in making its appearance in aquatic types. (3) Negative apostrophe can be induced in sun-loving plants in low light. (4) The effect of continued darkness upon grains already apostrophized is to drive them into masses in the corners, or, more rarely, upon the side-walls of the cell. (5) Still longer exposure to darkness may cause many, if not all, of the grains to come out on to the free walls. (6) Positively apostrophized grains of sun-lovers remain in apostrophe on removal to the dark.

The author proposes to term the whole range of possible grades of illumination from darkness to direct sunlight the *photrum*, and that portion of the scale which will be powerful enough to change the chloro-

* This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents (including Secretions); (3) Structure of Tissues; and (4) Structure of Organs.

† Journ. Linn. Soc. Lond.—Bot., xxiv. (1887) pp. 200-50 (1 pl. and 3 figs.).

phyll-grains from the condition of apostrophe to that of epistrophe, the *epistrophic interval* of the particular plant.

The length of a plant's epistrophic interval depends upon the quality of its protoplasm; and it would appear that if an epistrophic interval does not reach far to the right, it will extend some (perhaps all the) way upon the left side of the photrum. In the case of aquatics, however, the epistrophic interval is developed far more upon the left than upon the right side of the photrum.

The author then discusses the nature of the movement of chlorophyll-grains. The theory advanced may be shortly stated thus:—(1) Protoplasm is positively phototactic to light of medium intensity, and negatively so to high grades of illumination and to darkness. (2) The attracting and repelling actions of light impose a strain upon protoplasm. (3) Lowering of the tone of protoplasm as respects light results from withholding that agent.

Mr. Moore has included in this paper a table containing all the information he has been able to collect on what is called the "Law of Positive Progression," which may be expressed in a general way by saying that as an advance is made towards the positive end of the photrum, the corresponding movement of the chlorophyll is performed with more despatch, while the reverse is the case in proceeding towards the negative end. Some points in the rotation of the protoplasm of *Elodea* and *Vallisneria* are also touched upon; and the author concludes by giving the details of some experiments on the influence of light upon rotation.

Nuclear and Cell Division.*—Herr F. A. F. C. Went has examined afresh several undecided points in the processes of the division of the nucleus and of the cells.

With regard to the nucleoli, he determined that, at least in many cases, they are taken up into the nuclear threads on the commencement of the division of the nucleus. As an object for observing this process, he prefers the embryo-sac, especially of Monocotyledons, to pollen-mother-cells. The staining material employed was safranin, either in alcoholic or aqueous solution, and, for secondary staining, a mixture of diamond-fuchsin and iodine-green in a solution of equal parts of alcohol and water.

By the use of fuming hydrochloric acid, a reagent which dissolves chromatin, he also established the identity of the spindle-fibres and of the "combining-threads," the achromatic threads which unite the new nuclei while in the course of formation.

The author also describes the phenomena connected with the formation of the equatorial ring, which is accompanied by a shortening and thickening of the spindle-fibres, drawing along with them the two daughter-nuclei. This ring surrounds the cell-plate, and is distinguished by its power of taking up safranin.

Crystal-plastids.†—Under this name Herr A. Wigand describes certain protoplasmic structures which he finds very widely distributed within closed living tissue-cells, in root-hairs, aërial hairs, and in the epidermis and parenchyma-cells. These structures appear to be

* Ber. Deutsch. Bot. Gesell., v. (1887) pp. 247–58 (1 pl.).
† Wigand's Bot. Hefte, ii. (1887) pp. 44–87.

especially characteristic of the natural orders Gesneraceæ, Acanthaceæ, and Labiatæ, in very few species of which they were not detected, and were found also in plants belonging to a large number of orders of both Dicotyledons and Monocotyledons, as well as in *Azolla* and *Spirogyra*.

The author was frequently able to observe the formation of these bodies directly out of the cell-protoplasm. They resemble in appearance various forms of the Schizomycetes, micrococcus, bacterium, bacillus, leptothrix, &c. Their microchemical reactions appear to vary, but they are undoubtedly of a protoplasmic nature. They differ from true bacteria in their power of double refraction, but in many cases exhibit a very distinct power of spontaneous motion. They can even be artificially produced out of protoplasm by simple maceration at ordinary temperatures, and the author believes that in this respect they do not differ from true bacteria, which may also, if we judge from analogy, arise directly out of protoplasm without pre-existing germs.

At all events while still within the cell, and in certain cases also outside it, these structures have a distinct power of multiplication by bipartition. The author was unable to detect that they have any faculty of inducing fermentation. The "plastids" combine the characters of true bacteria and of crystalline structures. With the latter they agree in their double refrangibility; with the former in the characters already mentioned, but display greater resistance to acids and less resistance to staining reagents; their movements are also more sluggish, and liable to be altogether interrupted under certain conditions. They are bacteria in combination with a doubly refractive mineral substance, a combination to which the author applies the term "incrustation." From all other cell-contents, chlorophyll-grains, chromoplasts, starch-generators, &c., these plastids differ in their rod-like form, and in their power of division when outside the cell.

Separation of silver by active Albumin.* — In continuation of experiments by Loew and himself, Herr T. Bokorny finds that cells, when placed in an ammoniacal solution of silver, soon die, before any considerable separation of silver has taken place. In this case, therefore, the silver-reduction takes place only in dead cells, and this is the case also when the cells, after death, are placed for an hour in spring water and then again in the silver solution. The same reaction is also exhibited after killing with a 1 per cent. solution of ammonia, or with various alkaloids, such as strychnine.

Moderately dilute ammonia produces in the protoplasm, and, in *Spirogyra maxima*, also in the cell-sap, a separation of granules which possess a strong faculty for separating silver; this separation of granules does not take place in dead cells or in concentrated solution of ammonia. The author regards these granules as dense aggregations of albuminous substances, produced out of active albumin by a kind of polymerization. They did not exhibit the reactions of albumin, but were stained a bright red-violet in aqueous solution of fuchsin.

* Pringsheim's Jahrb. f. Wiss. Bot., xviii. (1887) pp. 194–217. Cf. this Journal, 1883, p. 225.

(2) Other Cell-contents (including Secretions).

Epidermal Chlorophyll.*—Mr. S. Le M. Moore states that we owe to Stöhr the greater part of our knowledge about the chlorophyll of epidermal tissues. Mr. Moore gives in this paper the details of some observations he has been making, and epitomizes his statements as follows:—

(1) As Stöhr has shown, all but a small percentage of Dicotyledons have chlorophyll in their epidermis; but in about half of these chlorophyll is found on the upper surface as well as the lower. Out of 120 angiospermous species observed by the author, 102 had chlorophyll in the epidermis of at least the under-side of the leaf; the number of Dicotyledons was 115, of which 101 furnished epidermal chlorophyll.

(2) Etiolin is formed in them, as in other chlorophyllous cells.

(3) In a considerable number (34 per cent.) of species with epidermal chlorophyll-grains, starch can be easily detected therein; in 24 per cent. a small quantity of starch is discoverable. Only 42 per cent. have absolutely starchless grains.

(4) There is no eventuality in the appearance of the starch, as De Bary states; for, on the one hand the grains can easily be discharged of and recharged with starch, which, on the other hand, is absent from the grains of some types through life.

(5) In any given case it is impossible to say *a priori* from the apparent depth of colouring shown by epidermal chlorophyll-grains, whether starch will or will not be found therein. This seems to support Pringsheim's theory of assimilation.

(6) The substance coloured blue by iodine and showing the tannin reaction with iron salts may perhaps be not tannin, but some substance closely related thereto.

Fluorescence of Chlorophyll.†—Dr. G. Cugini suggests that the purpose of the fluorescence of chlorophyll is in connection with its property of impeding the rays which are most efficacious in respiration from penetrating the leaves, thus rendering the respiration less intense, and making possible the process of the reduction of carbonic anhydride.

Preparation of Pure Chlorophyll.‡—After giving the history of the various substances described under the name of chlorophyll by different writers, and the mode of their preparation, Sig. L. Macchiati proposes the following method for preparing pure chlorophyll.

Fresh leaves are cut up into small fragments, repeatedly washed with distilled water and then with anhydric ether to remove the waxy substances, and are then boiled in alcohol until the solution acquires an intensely green colour. The solution is filtered while boiling; on cooling, a dark-green precipitate is obtained, which is red in transmitted light. This substance is identical with Bourgarel's erythrophyll. It can be obtained perfectly pure, and crystallizes in square plates. When this precipitate has been separated by filtering, the filtered liquid is concentrated, and the residue washed repeatedly with distilled water. The first portion of this water, which is of a golden yellow colour, may be used for the preparation of xanthophyllidrin. The residue is then dissolved in ether and allowed to evaporate, when needle-like crystals

* Journ. of Bot., xxv. (1887) pp. 358–63.
† Atti Congr. Naz. Bot. Critt. Parma, Sept. 1887, pp. 55–9.
‡ Malpighia, i. (1887) pp. 478–86.

appear on the sides and bottom of the vessel, which are dark green by reflected, brown by transmitted light. These crystals may be purified by repeated washing in cold alcohol and then with distilled water, and dissolved in ether. They dissolve with great difficulty in cold, easily in hot alcohol, and immediately in ether and chloroform. The ethereal and alcoholic solutions absorb the light of the spectrum between Fraunhofer's lines B and C. This is crystallized chlorophyll (Hoppe-Seyler's chlorophyllan). When its alcoholic solution is shaken with an equal quantity of pure benzin, it divides into an upper green layer, the chlorophyll of green leaves, and a lower yellow layer of xanthophyll.

The author then describes the method of obtaining other substances which are associated with chlorophyll, and discusses their composition.

Presence of active Albumin in the Cell-sap.*—Herren O. Loew and T. Bokorny state that they have discovered this substance in the cell-sap of several species of *Spirogyra*, e.g. *S. maxima*. If the living plant is treated with a 1 per cent. solution of a neutral salt of ammonium or of an organic base, granules are at once separated from the cell-sap which have a very powerful reducing effect on very dilute alkaline silver-solution, and give the ordinary reactions of albumen. They consist of active albumin, and appear at the same time in the parietal utricle; the latter remain fixed at the moment of their formation, while those separated from the cell-sap move about freely, and finally settle on the lower side of the cell. Neither kind of granule is formed if the cell is first killed by pressure; their separation is a function of life.

The authors adduce reasons against Pfeffer's hypothesis that these particles consist of tannate of albumen held in solution in the cell-sap by an acid; the cell-sap has not an acid reaction.

Fibrosin, a new cell-content.†—Herr W. Zopf describes a hitherto unknown substance which he finds in the conidia of *Podosphæra oxyacanthæ;* also in *Sphærotheca* and *Erysiphe*. It occurs as distinct bodies of various forms, imbedded in the protoplasm, never in the vacuoles, and apparently always present, usually from 5 to 15 in each conidium; they are readily separated by slight pressure on the cover-glass. The most usual form is that of roundish flat discs, less often conical and either truncated or not, rarely cylindrical. The longest diameter varies between 2 and 8 μ, the thickness between 0·5 and 0·7 μ. They readily swell up in hot water, lose their form, and retain only a stronger refrangibility. The behaviour of these substances is given in detail, from which the author draws the conclusion that they are of neither an oily, resinous, nor albuminous nature. They differ also in their properties from all known carbohydrates, and most closely resemble Fremy's fibrose. In germination they are used up in the formation of the germinating tube, and must, therefore, from a physiological point of view, be regarded as a reserve-substance.

Secretion from the Roots.‡—Dr. H. Molisch states that the acid secretion from roots attacks organic even more powerfully than inorganic substances, not merely dissolving them, but causing important chemical changes. It exercises both a reducing and an oxidizing power. It stains guaiacum blue. It oxidizes tannin and humin-substances, and

* Bot. Ztg., xlv. (1887) pp. 849-57.
† Ber. Deutsch. Bot. Gesell., v. (1887) pp. 275-81 (1 pl.).
‡ SB. K. K. Zool.-Bot. Gesell. Wien, xxxvii. (1887) p. 65.

hence promotes greatly the decomposition of humus in the soil. It transforms cane-sugar into reducing sugar, and has a slight diastatic action. Plates of ivory are corroded by it. The root behaves in many respects like a fungus, in so far as the fungus alters the organic constituents of the soil by definite excretions, and causes their more rapid decomposition. This root-secretion does not merely impregnate the epidermis, but is often excreted over it in the form of drops.

Formation of organic acids in the growing parts of plants.*—Herr W. Palladin deduces from the facts already known respecting the formation of asparagin and of vegetable acids in the course of the growth of plants, that the formation of cellulose in growing organs must be accompanied by a strong elimination of oxygen; that organic acids are formed in these organs as a secondary product of the re-formation of albuminoids from asparagin and carbohydrates; and that the water formed in the respiration of growing organs is also a product of this same process.

Localization of Emulsin in Almonds.†—M. Johannsen states that bitter almonds contain a glucoside, *amygdalin*, and a soluble ferment called *emulsin* or *synaptase*. Having to study the question of the localization of emulsin, the author gives the following as the conclusion to his researches, viz.:—That amygdalin and emulsin are localized in different tissues. Amygdalin (which is only found in bitter almonds) is localized in the parenchyma of the cotyledons, and emulsin (which is found in all almonds) is localized in the axile parts of the embryo and in the fibrovascular bundles of the cotyledons.

(3) Structure of Tissues.

Development of Stomata.‡—Herr E. Immich finds that very good objects on which to study the early development of stomata are the leaves of both Monocotyledons and Dicotyledons, either when just emerged from the bud-scales or at somewhat later stages; the plants specially observed were *Syringa*, *Cratægus*, *Prunus*, *Acorus*, *Scirpus*, and Palmæ. The careful examination of a large number of cotyledons, especially of many Cruciferæ and Compositæ, shows, on sections of the epidermis, smaller cells of simpler and very characteristic form, the mother-cells of the stomata. In their external contour these cells are not unlike spherical triangles. They are formed by an ordinary epidermal cell being first divided by a central septum into two segments of equal size. From this wall proceeds a second curved wall to the lower part of the cell, and from about the middle point of this a third at an angle of about 60°; the mother-cell of the stoma being then formed. A nucleus is formed in this mother-cell, and it divides into two segments of unequal size by a division-wall a little above its middle. All this takes place while the seeds are still inclosed in the carpels and in quite a young pulpy condition.

In the Leguminosæ the above course of development occurs in the section Phyllolobæ, in which the cotyledons rise above the soil and develope into ordinary leaves (*Melilotus*, *Lotus*, *Trifolium*, &c.); while in the Sarcolobæ, where the cotyledons remain beneath the soil (*Vicia*, *Ervum*, *Pisum*), the course is somewhat different. No rudiments of

* Ber. Deutsch. Bot. Gesell., v. (1887) pp. 325-6.
† Ann. Sci. Nat., vi. (1887) pp. 118-26.
‡ Flora, lxx. (1887) pp. 435-46, 459-66, 467-82 (1 pl.).

stomata were here found on the cotyledons; but, on the other hand, there were on the plumule and first leaves of the erect shoot. The same is the case with the Phaseoloideæ.

In other families of Dicotyledons the mother-cells of the stomata were found on the cotyledons while still within the seed, substantially as in Cruciferæ and Compositæ. The occurrence of the triangular mother-cell is much less common among Monocotyledons. Those of grasses are characterized by their oval form, and having almost invariably two cells, one on each side, which distinguish them from all the other cells of the epidermis.

As the young stoma does not, in ordinary cases, reach quite as far as the subjacent palisade-parenchyma, we have, in the air-space thus formed, the first indication of the "breathing-hole." Very early the nucleus loses its central position in the mother-cell of the stoma, and occupies a somewhat higher position; the protoplasm becomes turbid, and a few pale-green chlorophyll-grains make their appearance.

The processes are somewhat different in those cases, which occur chiefly in evergreen and other coriaceous leaves, where the stoma is depressed to a lower level than that of the other epidermal cells. In the case of *Allium Cepa* this occurs not by any change in position of the mother-cell of the stoma, but by energetic growth of the neighbouring epidermal cells. In grasses, on the other hand, the mother-cell itself takes part in the difference of level; and in Coniferæ appears to be the chief agent in the depression. In order to accomplish this the mother-cell, as it develops, loses its oval form, and becomes wedge-shaped below, the wedge forcing its way deeper and deeper between the epidermal cells, which it forces aside, until it becomes so greatly depressed that it is almost in contact with the palisade-cells. The fissure is not formed until after this process is completed.

Protecting-wood and Duramen.*—By "protecting-wood" (Schutzholz) Herr E. Praël understands that new wood formed on wounds, which can be distinguished even by the naked eye from its brown colour. The wood thus formed exhibits great resemblance to ordinary duramen in the special cell-contents which characterize it—gum and resin, and also in the occurrence of thyllæ. The formation of thyllæ and of gum occurs in the same plant. The colouring of the cell-walls is exhibited both by the protecting-wood and by duramen; the identity of the two is especially seen in coloured woods. The hermetical closing of surfaces of the wood prevents, or at least hinders, the formation of protecting-wood.

Split Xylem in Clematis.†—Dr. F. Krasser describes the peculiar fissured appearance of the xylem in the vascular bundles of *Clematis Vitalba*, which resembles that in the climbing Bignoniaceæ, but results from a different cause. It depends on the intermediate bundles between the primary bundles originating later, and producing less xylem than a leaf-trace bundle; the difference in the radial development of the xylem producing to the eye the appearance of a fissure.

Apical meristem of the roots of Pontederiaceæ.‡—Herr S. Schönland has examined the structure of the apical meristem in the roots of

* Ber. Deutsch. Bot. Gesell., v. (1887) pp. 417–22.
† Verhandl. K. K. Zool.-Bot. Gesell. Wien, xxxvii. (1887) pp. 795–8 (3 figs.).
‡ Ann. of Bot., i. (1887) pp. 179–82 (2 figs.).

Eichhornia azurea and *crassipes*. The best mode of treatment he finds to be to soak the sections in potash for twenty-four hours, treating with acetic acid, and then mounting in glycerin, or to stain with Kleinenberg's hæmatoxylin after treatment with potash, and mounting in Canada balsam. Examined in this way he finds that, even in the youngest stages of the adventitious roots, it is quite impossible to refer the root-cap to the same initials which give rise to the dermatogen and periblem; there is a distinct calyptrogen layer. The young adventitious roots of the Pontederiaceæ have, in fact, very much the same structure as the primary roots of *Pontederia cordata*, and belong therefore to the type of the Gramineæ.

(4) Structure of Organs.

Endosperm of Gelsomineæ (Jasmineæ).*—Prof. R. Pirotta has tested the correctness of the usual statement that in this family, a suborder of Oleaceæ, comprising the genera *Jasminum*, *Menodora*, and *Nyctanthes*, the endosperm is entirely wanting or reduced to a mere rudiment. He finds, on the contrary, endosperm invariably present in the mature seed. In *Menodora*, and in some species of *Jasminum*, the cotyledons are foliaceous, and the endosperm is then well developed; in other species of *Jasminum* the cotyledons contain a large amount of reserve-substance, and in these the endosperm, though still always present, is reduced to a small number of cells.

Salt-excreting glands of Tamariscineæ.†—Dr. R. Marloth contests Volkens' theory that the glands on species of Tamariscineæ inhabiting the deserts, such as *Reaumuria hirtella*, which excrete an incrustation of salt over the surface of the organ, have the power, through their hygroscopic properties, of taking up the water which is precipitated through the air, and transmitting it to the assimilating tissue. He maintains that the purpose of the incrustation is, on the one hand, to serve as a non-conductor of heat, on the other hand to diminish transpiration.

To this Herr G. Volkens replies,‡ pointing out that at all events the second hypothesis of Dr. Marloth is hardly consistent with the fact that the excretion of salt is in the form of a loose and very unequally distributed powdery mass.

Organs for the absorption of vegetable food-material by plants containing chlorophyll.§—Herr L. Koch describes peculiar organs on the roots of species of *Melampyrum*, especially *M. pratense*, connected with the absorption of nutriment from the soil in which they grow, and which contains great quantities of the decaying roots of grasses and stem of mosses, and the mycelium of Fungi. The root-system of *Melampyrum*, penetrating into this substance, consists of a primary root and lateral roots, which force their way through this layer into soil containing very little or no organic matter. These roots grow to a considerable thickness, and serve as a support to long slender roots proceeding from these, which play the greatest part in the absorption of food-material. These slender roots are of endogenous origin with rudimentary root-cap, and proceed often in crowded clusters from spots in the principal roots, which are in contact with the organic substratum.

* Malpighia, i. (1887) pp. 427–34 (1 pl.).
† Ber. Deutsch. Bot. Gesell., v. (1887) pp. 319–24. Cf. this Journal, *ante*, p. 81.
‡ Ibid., pp. 434–6.
§ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 350–64. Cf. this Journal, *ante*, p. 81.

Both they and the thicker roots are but sparsely endowed with root-hairs. When these slender roots come into contact with organic substances in the substratum, protuberances are formed on them, the structure and mode of formation of which are described in detail. In some cases both the nutrient object and the protuberance are invested by a number of fine hairs springing from the latter. From its apex the protuberance puts out a kind of clasp by which it attaches itself to the nutrient object, somewhat after the manner of a haustorium, some of the cells of the protuberance actually penetrating into the nutrient substance. These protuberances have often only a temporary existence, perishing with the complete decay of the nutrient substance.

The special function of these organs the author believes to be the absorption from the soil of nitrogenous food-material.

Haustoria of the Rhinantheæ and Santalaceæ.*—M. Leclerc du Sablon states that while non-parasitic phanerogamous plants absorb the necessary liquid food by means of the root-hairs, parasites, such as *Cuscuta* and *Orobanche*, absorb liquids by means of special organs called haustoria (*suçoirs*). In a third category of phanerogamous plants the mode of nutrition partakes somewhat of the above two methods combined. In the Rhinantheæ and Santalaceæ the absorption of liquids takes place both by root-hairs and by haustoria.

The author describes the haustoria of the Rhinantheæ, taking *Melampyrum pratense* as an example. The roots of this plant are normally destitute of root-hairs; the haustoria commence to form towards the extremity of the roots shortly after germination. A slight projection is seen on the sides of the root; the two layers of cells which constitute the cortical parenchyma elongate radially, and divide by septa in different directions. This is the commencement of the formation of the haustorium. In the Santalaceæ the commencement of the formation of the haustorium is first seen in a layer of cells beneath the superficial cells of the cortex of the root, the superficial cells being already dead.

In another paper by the same author,† the development and structure of haustoria in Rhinantheæ and Santalaceæ are more minutely described. In the Rhinantheæ both cortex and pericycle take part in the formation of haustoria. On the sides of the haustoria the cells of the piliferous layer develope into root-hairs; towards the extremity a certain number of cells become differentiated, and penetrate into the host. The absorbing cells advance into the tissue of the host, either in a bundle or more often isolated. The Rhinantheæ, then, in every case absorb their liquid nutriment by means of the cells of the piliferous layer. In the Santalaceæ, and especially in *Osyris*, which bears few haustoria, root-hairs are formed. In this family the haustoria are also formed by the cortex and pericycle, but here the pericycle plays a more important part than in the Rhinantheæ. In the portion of the haustorium near to the root, a central cylinder and a cortex can be distinguished; the limit is marked by an endoderm. Towards the extremity of the haustorium the endoderm disappears, and at the same time the distinction between cortex and central cylinder.

In every case the absorbing cells are connected with the xylem-bundles of the root by a bundle composed of spiral cells.

* Comptes Rendus, cv. (1887) pp. 1078–81. Cf. this Journal, *ante*, p. 80.

† Ann. Sci. Nat., vi. (1887) pp. 90–117.

Structure of the root and arrangement of the rootlets in Centrolepideæ, Eriocauleæ, Junceæ, Mayaceæ, and Xylideæ.*—M. P. Van Tieghem states that the structure of the root and arrangement of the rootlets have been frequently studied in Gramineæ and Cyperaceæ. In this paper the author describes these features in some of the other closely allied monocotyledonous groups. He concludes by stating that the anomaly of having the pericycle of the root regularly interrupted outside the woody bundles, and of forming in consequence the rootlets, opposite the liber-bundles, has been observed up to the present in seven families of Monocotyledons, namely, Xylideæ, Mayaceæ, Junceæ, Eriocauleæ, Centrolepideæ, Cyperaceæ, and Gramineæ.

Geminate Root-hairs.†—M. P. Van Tieghem states that occasionally a differentiation takes place in the piliferous layer of the root, the root-hairs undergoing a special grouping which merits attention. In the root of *Pœpalanthus* the piliferous layer is composed of both long and short cells. The short cells, which are tabular in form, are sometimes prolonged directly into hairs, but more often they are divided into two halves by longitudinal septa. These two sister-cells then develope towards the exterior into two hairs, which diverge in the form of a V. This arrangement may be met with more especially in certain Eriocauleæ and Junceæ.

Root-tubercles of Leguminosæ.‡ — Dr. O. Mattirolo and Sig. L. Buscalioni have made a further examination of the nature of these structures, chiefly on various species of *Vicia*. They conclude, for the following reasons, that the bacterium-like substances found in the cells of these structures are not living bacteria, but bacteroids, protoplasmic bodies endowed with brownian movement. Experiments on culture of these bodies, under the most favourable circumstances, produced entirely negative results. They broke up into smaller particles, which displayed similar movements. Immersion for twenty minutes in boiling water did not destroy this movement; and they were unaffected by a temperature of 130° continued for two hours, and by various antiseptics. The form also is very variable: usually somewhat that of a Y with unequal branches, but varying to that of an X, or exhibiting numerous branches.

Tubercular Swellings on the Roots of Vicia Faba.§—Prof. H. Marshall Ward has succeeded in producing, by infection, the tubercular swellings on the roots of a number of leguminous plants, especially on *Vicia Faba*. He attributes their formation to hypertrophy of the tissue caused by the attacks of an undetermined parasitic fungus, probably belonging to the Ustilagineæ. He was able to trace hyphæ of this fungus penetrating through the whole length of a root-hair, and then traversing the cortex of the root, piercing the cell-walls, at which spots they manifest peculiar trumpet-like enlargements, and branch when they reach the tissue of the young tubercle. In addition to the hyphæ which traverse the cell-cavities, there are always found minute corpuscles suspended in the protoplasm of the cells. These Prof. Ward believes to be gemmæ or bud-like outgrowths from the hyphæ; the fungus having lost its

* Morot's Journ. Bot., i. (1887) pp. 305–15.
† Ann. Sci. Nat., vi. (1887) pp. 127–8.
‡ Malpighia, i. (1887) pp. 464–74, 536–41. Cf. this Journal, 1887, p. 987.
§ Phil. Trans., clxxviii. (1887) pp. 539–62 (2 pls.). Cf. this Journal, 1887, p. 1005.

power of producing resting-spores, and being propagated in this manner only. It is the presence of these parasitic gemmules that stimulates into increased activity the protoplasm of the cells themselves.

The author describes the method by which he was successful in infecting healthy roots of the bean by placing them in contact with diseased tubercles; and finally combats Brunchorst's and Tschirch's view,* that the so-called "bacteroids," or bacterium-like particles, always found in the cells of the tubercles, are modifications of the protoplasm of the cells.

Emergences on the Roots of Podocarpus.†—Dr. T. A. Baldini has investigated the structure of peculiar bodies already described by Van Tieghem on the roots of several species of *Podocarpus*. In all the species they are of endogenous origin, springing from the second or third layer of cells below the epidermis; they are formed by walls, the earlier of which are tangential, the later radial. As regards their function, the author believes this to be the absorbing and storing-up of water from the soil. They may also serve as reservoirs for starch and other formative substances.

Stipules.‡—M. G. Colomb states that stipules are of such various forms, and occupy such different positions in relation to the leaf, that it is hardly safe to define a stipule from external characters alone. The author has therefore studied the anatomical structure of this organ in many plants belonging to different natural orders, the details of which are given in this paper. He describes a stipule as an incomplete axillary ligule, and draws the following conclusions from his researches:—

Three regions may be recognized in a ligule, viz.:—(1) *The lateral region*, in which the marginal bundles of the sheath are simply prolonged. (2) *The stipular region*, where the bundles form a part of the last bundle of the sheath entering the leaf. (3) *The axillary region*, which unites the two stipular regions.

If the ligule is complete with its three regions, the author has given to it the name of *axillary ligule;* if the stipular and axillary regions only are present, the sheathing regions having disappeared, it is an *axillary stipule;* but if finally the axillary region is divided lengthwise into two halves, the one on the right and the other on the left, and the stipular regions exist solely at the base of the petiole, it is then an *ordinary stipule*.

Stipule and ligule are then organs of the same nature, between which it is possible to find every variety of modification, the stipule being a portion of the axillary ligule. A stipule can be defined as an appendix inserted on the stem, at the base of the leaf, the bundles of which belong exclusively to the corresponding foliar bundles.

Vernation of Leaves.§—Herr R. Diez classifies the various modes of the vernation of leaves under a number of different heads, viz.:—*Flat* (*Viscum*); *apposite* (zusammengelegt) (*Prunus Laurocerasus*); *imperfectly apposite* (*Fagus*); *apposite and rounded* (*Parnassia palustris*); *wedge-shaped* (*Veronica Andersoni*); *folded and radiate* (*Acer platanoides*); *folded and acute-angled* (*Pritchardia filamentosa*); *folded lengthwise and curved* (*Dioscorea villosa*); *folded across and curved* (*Castanea*). These

* See this Journal, 1887, p. 610.
† Malpighia, i. (1887) pp. 474–7.
‡ Ann. Sci. Nat., vi. (1887) pp. 1–76.
§ Flora, lxx. (1887) pp. 483–97, 499–514, 515–80 (1 pl.).

may also be combined in a variety of ways. These terms (except the first) apply to various modes of folding; there are also a number of ways in which the leaves may be rolled up before opening, viz.:—*Spirally twisted* (eingerollt) (*Musa*); *twisted right or left*; *spiral and imbricate* (übergerollt) (*Escallonia macrophylla*); *spiral and valvate* (gerollt) (*Specularia perfoliata*); *channelled* (*Linum usitatissimum*); *cornet-shaped* (*Spironema fragrans*); *involute* (*Nymphæa*); *revolute*; *circinate* (*Utricularia montana*).

With regard to the value of vernation for systematic purposes, there are very few families in which the mode is uniform throughout all the species. In Nymphæaceæ the floating leaves are always involute on both sides; in Polygonaceæ the leaves are always revolute on both sides; in Scitamineæ spirally involute; in Mimoseæ the pinnæ are always flat. In other families the vernation is uniform throughout, with the exception of a few genera or species. Within the genus the mode is usually the same with the same form of leaf, but most generally varies when the form of leaf varies.

The vernation of leaves is also influenced by the nature of the venation, by the consistency of the leaf, and by the presence of stipules or leaf-sheaths. The floating or submerged leaves of water-plants appear to be flat or rolled in vernation, never folded. The purpose of the different modes is the protection of the leaves in the bud-condition. The position of the leaves assumed during sleep or under the influence of irritants is usually partially, but not entirely, a reversion to the position in vernation.

Double Leaves.*—By a double leaf Dr. M. Kronfeld understands one which bears two laminæ on one petiole. He distinguishes between an *epidiphyllum*, where the growth of the lamina has been interrupted at a particular spot, and a *paradiphyllum*, resulting from dichotomy of the lamina. The former occurs normally in *Dionæa*, and probably also in *Nepenthes*; the latter chiefly in particular varieties, especially of ferns, such as *Asplenium Trichomanes ramosum*.

Pitcher-like leaflets of Staphylea pinnata.†—M. Lachmann describes the not uncommon formation of pitchers by some of the leaflets in this plant. It results from the more or less complete union of the edges of the lamina, so that either the whole, or only the upper part of the leaflet takes the form of a cornucopia; in the latter case the normal lower portion of the leaflet is connected with the pitcher by means of a stalk. He concludes from analogy that in *Nepenthes* the pitcher must be regarded as the terminal portion of a lamina, the basal part of which remains flat.

Clinging-Plants.‡—Dr. E. Huth describes the various means by which plants attach themselves to the fur or skin of animals, by hooked or barbed hairs attached to the seed-vessels or some other part of the plant, or by other contrivances, for the purpose of propagation. Under each natural order the plants are named and described in which these contrivances are found.

Heterophylly.§—According to Dr. F. Krasser, when two different forms of leaf occur on the same plant, it may be an example of true

* SB. K. K. Zool.-Bot. Gesell. Wien, xxxvii. (1887) pp. 74–6.

† Bull. Soc. Bot. Lyon, 1886. See Bull. Soc. Bot. France, xxxiv. (1887), Rev. Bibl., p. 151.

‡ Uhlworm u. Hänlein's Biblioth. Bot., Heft ix., 1887, 36 pp. and 78 figs.

§ SB. K. K. Zool.-Bot. Gesell. Wien, xxxvii. (1887) pp. 76–8.

heterophylly, when it depends on something inherent in the organization, or of *anisophylly*, when it is the result of a difference of position, as in the case of aquatic plants where the floating and the submerged leaves differ in form. In the former case the cause is unknown, and the two kinds of leaves may pass into one another by insensible gradations, as in *Broussonetia* and *Morus*. Both may be the result either of progression or of retrogression.

Colours of Leaves and Fruits.*—Herr A. Wigand has investigated the nature and the cause of the red and blue colours of a large number of leaves and fruits. He classifies the very numerous examples mentioned under a number of heads. In many plants the stem and leaves exhibit normally and constantly a red or blue colour in the form of streaks or spots. In others, especially woody plants, it appears only as the branches and leaves unfold; in the "copper" varieties of trees, such as the ash, beech, hazel, or elm, it increases in intensity as the leaves develope; while in others it appears only in the autumn, and either in connection with the dying of the leaves or not. Many plants exhibit these colours only locally as the result of injury, especially puncture by insects. In many fruits, especially such as are fleshy, the red or blue colour appears only during ripening, and then obviously depends on the influence of light. Many rhizomes also exhibit a red colour.

The colour generally preponderates on the upper side of the leaf, or is limited to that side; usually it is contained only in the cell-sap; less often it colours also the cell-walls. The seat of the red colour may be either the epidermis, the parenchyma, or the vascular bundles; the order in which it makes its appearance is always:—(1) the veins, (2) the epidermis, (3) the parenchyma.

The colour of most ripe berry-like fruits is due either to insoluble pigment-particles, or to a homogeneous colouring of the cell-sap. It is not in any way due, as some have maintained, to a modification of chlorophyll. Some plants with coloured stems, e. g. *Cuscuta*, contain erythrophyll, but never chlorophyll. The colouring matter may be contained in different cells from the chlorophyll, or in the same. The chromogen or colouring constituent of the pigment the author believes to be a form of tannin.

Alpine vegetation is especially characterized by the tendency to a red colouring. The author considers that the conditions specially favourable to the production of either red or blue colour are a feeble or completely suppressed assimilation and a strong light.

Anatomy of the Floral Axis.†—Herr K. Reiche gives details of several points of structure in the axis of flowers, and of inflorescences, especially in connection with the contrast between those of male and of female flowers. In *Cucurbita Pepo* the female flower-stalk is distinguished from the male by its greater thickness, and by its strong bicollateral vascular bundles containing cambium, while the much smaller bundles of the male flower-stalks have no cambium; both kinds have a hypodermal ring of collenchyma. In other cases the chief characteristic of the female as contrasted with that of the male axis, is the larger quantity of starch-containing tissue. This is strikingly the case in *Mercurialis perennis*,

* Wigand's Bot., Hefte ii. (1887) pp. 218–43.

† Ber. Deutsch. Bot. Gesell., v. (1887) pp. 310–8 (1 pl.). Cf. this Journal, *ante*, p. 79.

and in *Platanus*. That the increase in the size and number of the vascular bundles is directly incited by the weight of the fruit, is shown by the fact that when female flowers remain unfertilized, as is the case with large numbers in the oak, walnut, and horse-chestnut, the axis retains the structure characteristic of that of fugacious male flowers.

In the case of neuter flowers, the structure of the axis varies according to that of the flower itself. Where sterility results from the conversion of stamens into petals, as in the case of the double tulip, the scape is twice as thick as in the case of a single flower, and has a correspondingly increased number of vascular bundles. When, as in *Hydrangea* and *Viburnum Opulus*, the sterile flowers are fugacious and simply for the purpose of display and of attracting insects, the axis has the characters of that of male flowers.

Comparative Anatomy of Flowers.*—Rev. G. Henslow follows up previous observations on the relation of floral organs to their vascular cords or "axial traces." Taking the cords as "floral units," the author suggests their relation to axes as well as to all kinds of floral appendages. The two elements of a cord are tracheæ or spiral vessels and sieve-tubes, &c., or soft bast; Van Tieghem's distinction between axial and foliar characters of cords is not constant. Mr. Henslow discusses the origin of umbels in exogens and in endogens, the influence of the union of the cords on phyllotactical arrangement, the multiplication of parts arising from the "chorisis" of a cord, the undifferentiated state of organs when in congenital union, the non-axial character of almost all placentation, &c. The free-central placentation of Primulaceæ is interpreted as due to the coherent and ovuliferous bases of five carpels, which have the upper parts of their margins cohering in a parietal manner and without ovules. The author proposes continuing his observations.

Floral Nectary of Symphoricarpus.†—Prof. F. Delpino corrects a mistaken description by H. Müller, Bonnier, and others, of the floral nectary in *Symphoricarpus racemosus*. The purpose of the hairs which clothe the tube of the corolla he states to be, not to protect the nectar from rain, but to prevent the entrance of insects which would be injurious by feeding on the nectar without assisting in the pollination of the stigma, especially of ants.

Fruit of Borragineæ.‡—Fräulein A. Olbers describes five different kinds of fruit and of the structure of the pericarp in Borragineæ. This is connected also with differences in the structure of the "foot," which Fräulein Olbers believes to have no function, in general, in connection with the storing up of water for germination, but rather with the bursting and detachment of the fruit.

Explosive Fruits of Alstrœmeria.§—Dr. O. Stapf describes the structure of the ripe capsule of *Alstrœmeria psittacina*, and the cause of its violent rupture. This depends on the differentiation of the development of different layers of the placenta, which consists eventually of three horny clasps, firmly attached at the apex to the lobes of the capsule, and separated by thin-walled parenchyma. Finally, these clasps

* Proc. Roy. Soc., xliii (1887) pp. 296–7. † Malpighia, i. (1887) pp. 434–9.
‡ SB. Bot. Sällsk. Stockholm, May 31, 1887. See Bot. Centralbl., xxxiii. (1888) p. 88.
§ SB. K. K. Zool.-Bot. Gesell. Wien, xxxvii. (1887) pp. 53–5.

give way suddenly at the point of contact with the lobes; the capsule is violently burst open, and the smooth round seeds thrown out to a distance which may amount to four metres. The same mechanism occurs in other species of the genus.

β. Physiology.*

(1) Reproduction and Germination.

Pollination of Serapias.†—Dr. L. Nicotra describes the mode of pollination in two Italian species of *Serapias*, *S. lingua* and *occultata*. In the latter species the structure of the flower is favourable to homogamy. The pollen-masses become disintegrated into cubical massulæ which fall in large numbers into the stigmatic cavity; and pollen-tubes can be seen in great quantities passing into the ovary. In *S. lingua*, on the other hand, homogamy is almost impossible, and yet it appears to be left almost entirely unvisited by insects. Pollen-masses are very rarely to be seen on the stigma, and it is very rare for this species to produce capsules and fertile seeds.

Pollination in Zannichellia palustris.‡—M. E. Roze thus describes the floral arrangement of *Zannichellia palustris*:—The female flower is composed of a membranous, cupuliform perigyne, inclosing two to six pistils, at the base of which will be found the male flower consisting of a single stamen. The filament of this stamen, which at first is almost sessile, becomes longer than the pistils before flowering. When ripe, the pollen escapes and falls into the water, and the funnel-shaped stigmas immediately below the stamen receive those grains which touch any point of their surface in their fall. It only remains now for the pollen-grains to emit their tubes and penetrate to the embryo-sac; but this has not been actually observed by the author.

Production of Sex and phenomena of Crossing. §—Dr. F. Nobbe states, as the result of a number of experiments, that seeds of *Leucojum* which germinate rapidly (in three to four days) produce chiefly or exclusively plants with double flowers; while those of the same species which germinate slowly (in nine to ten days) produce chiefly single fertile flowers. In hybridization he finds the hybrid to reproduce the characters of the male ancestor in the inflorescence and in the relationship of the double to the single flowers; while the colour of the flower is intermediate between that of the male and the female parent.

Physiological Organography of Flowers. ‖—Herr K. F. Jordan describes the structure, in reference to the mode of pollination, of a number of flowers belonging to the following classes, viz.:—(1) Actinomorphic honey-flowers; (2) actinomorphic pollen-flowers (i. e. those in which there is no nectary, but the pollen is devoured by the visiting insect (*Convallaria majalis*); and (3) zygomorphic honey-flowers. In all he finds a direct adaptation, in the position of the nectary, and in the position and mode of dehiscence of the anthers, to pollination by insects,

* This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth (including Movements of Fluids); (3) Irritability; and (4) Chemical Changes (including Respiration and Fermentation).

† Malpighia, i. (1887) pp. 460–3.

‡ Morot's Journ. Bot., i. (1887) pp. 296–9 (1 fig.).

§ SB. Deutsch. Naturf. u. Aerzte, Wiesbaden, Sept. 20, 1887. See Bot. Centralbl., xxxii. (1887) p. 253. ‖ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 327–44 (1 pl.).

or at least by one particular species of insect. Even where the visits of such an insect have not been actually observed, they must be assumed from the structure of the flower.

Bigeneric Orchid Hybrids.*—Mr. R. A. Rolfe sums up his conclusions on this subject as follows:—

(1) Hybridization may take place not only between distinct species, but also between distinct genera of orchids.

(2) These hybrids are generally of artificial origin, or accidentally produced, and cannot be treated in the scheme of classification either as varieties, species, or genera.

(3) The possibility of hybridization taking place between species hitherto considered as distinct does not necessarily prove them to be merely forms of the same species.

(4) The occurrence of a hybrid between two structurally different genera does not prove the necessity of uniting them in one; nor can hybrids be arbitrarily referred to either of the parent genera.

(5) Species, and genera too, will always have to be dealt with in the scheme of classification according to their structural peculiarities and differences, without reference to the possibility of hybridization taking place between them. It is therefore clear that hybrids, whether bigeneric or otherwise, should be dealt with on their own merits, and named in such a way as to avoid all confusion between them and existing species and genera. In the case of bigeneric hybrids the plan of compounding a name from that of the two parents should always be followed, as "*Philageria X*," a name invented by Dr. Masters for a hybrid raised by crossing *Lapageria rosea* with the pollen of *Philesia buxifolia*. By this means all confusion between them and natural genera would be avoided.

Germination of Palms.†—Herr O. Gehrke has observed the mode of germination of the seeds of a number of species of palms, and finds that they all agree in all essential features. The subordinate points in which they differ are examined in detail, especially in the case of *Phœnix dactylifera*.

(3) Nutrition and Growth (including Movements of Fluids).

Importance of the Mode of Nutrition as a means of Distinction between Animals and Vegetables.‡—M. P. A. Dangeard considers the Chlamydomonadineæ to form a group of the same rank as the Chytridineæ; the two groups are both related to the Flagellata, but they do not diverge at exactly the same point. The Chytridineæ are intimately allied to the zoosporous monads, only differing from these latter in the manner of nutrition; the Chlamydomonadineæ appear to separate from the Flagellata a little higher in the series. Within these limits the development between an animal and a plant does not differ sensibly. The author then describes in detail the mode of nutrition of *Pseudaspora Nitellarum* Cnk. and *Sphærita endogena* Dangeard. The former species, when forming its sporange, introduces starch into the interior of its chlorophyll-grains, the starch being obtained from the protoplasm of

* Journ. Linn. Soc. Lond.—Bot., xxiv. (1887) pp. 156–70.

† Gehrke, O., 'Beitr. z. Kenntniss d. Anat. v. Palmenkeimlingen,' 29 pp., Berlin, 1887. See Bot. Centralbl., xxxii. (1887) p. 265.

‡ Comptes Rendus, cv. (1887) pp. 1076–8.

the cell of the alga in which it is found. *Sphærita endogena* at no stage of its existence introduces solid particles in its protoplasm. We are in this case, then, easily able to distinguish the one from the other; the former being an animal, and the latter a vegetable.

The author concludes by stating that the Chytridineæ and Chlamydomonadineæ are two primary groups of the vegetable kingdom; the one being related to the algæ, the other to the fungi. Their mode of nutrition alone allows of their vegetable nature being recognized.

Growth of the Leaf-stalk.*—Herr P. G. Uhlitzsch compares the mode of growth of the leaf-stalk with that of other axial organs, and finds that it is governed by the same general laws. On the boundary of the leaf-stalk and lamina there is usually a growing-point, from which proceeds the activity of growth of the organ.

Modes of Climbing in the genus Calamus.†—Prof. F. O. Bower states that it is of the greatest importance to climbing plants that the assimilating leaves should be exposed to the sunlight; and this they strive to effect by a straggling habit, and by the help of adaptation for mechanical support on other plants. If, in the case of *Calamus*, the axillary bud were developed as a flagellum, but remained inserted in the axil of the next lower leaf, the two members, being extended in the same plane and the leaf being the lower, it is improbable that the lower portion of the flagellum would come in contact with any support. But the case is otherwise when the axillary bud is displaced and adherent to the sheath of the next higher leaf; it is thus clear of its own subtending leaf, and projects freely from the shoot at a point considerably above it. This being so, it is probable that, as the plant straggles through and over the surrounding vegetation, even the lower parts of the flagellum will have an opportunity of affording support to the whole shoot.

The two sections of the genus *Calamus* show two very distinct types of adaptation of the shoot to meet the exigencies of a climbing habit: the one developes the apex of the leaf, the other the axillary bud of the flagellum. Thus we see how plastic is the vegetative shoot in its mode of development within a single genus.

Assimilation and Respiration of Plants.‡—Herr U. Kreusler, in this continuation of former experiments,§ gives the details of experiments made with the shoots of the same kind of plant, *Philadelphus grandiflorus*, at different stages of growth, the temperatures of observation being 15° and 25°. At a temperature of 25°, a strong and marked decrease in assimilative power accompanies increasing age of the leaf; at 15° a maximum of assimilative power is noticed in the youngest leaves. This power reaches its minimum at the period of blossom, and rises again in the oldest leaves; so that between the assimilative power in the youngest and in the oldest leaves there does not exist much difference. A table showing the amount of water absorbed at the different temperatures is also given.

In the second portion of this paper, amongst many statements concerning the absorption and exhalation of carbonic anhydride at different

* Uhlitzsch, P. G., 'Unters. üb. d. Wachsthum d. Blattstiele,' 62 pp. and 4 pls., Leipzig, 1887. See Bot. Centralbl., xxxii. (1887) p. 263.

† Ann. of Bot., i. (1887) pp. 125-31.

‡ Journ. Chem. Soc. Lond., 1888, Abstr., pp. 186-7, from Bied. Centr., 1887, pp. 669-81.

§ Cf. Bied. Centr., 1887, p. 110.

temperatures, it is recorded that the range of temperature in which exhalation occurs is from 0–50°, and that it is greatest at the highest temperature, the maximum appearing to be at 46·4°. Assimilation seems to take place at a lower temperature than exhalation, and it is active at 50°; but the curve representing the relation of assimilation to temperature does not agree with that representing exhalation at various temperatures. In the case of the bramble, the maximum intensity of exhalation occurs at about 46·6°, whilst that of assimilation is found at 25°.

Influence of Atmospheric Movement on Transpiration.* — Prof. J. Wiesner gives an account of his observations on the influence of atmospheric movements on the transpiration of plants. (1) Movements of the air corresponding to a medium wind velocity for the season (about 3 metres per second), exercise an important influence on the transpiring portions of the plant. (*a*) Physiologically this is expressed in an increase, less frequently in a decrease of the transpiration. (*b*) Anatomically the influence is expressed in a narrowing or closure of the stomata. A plant like *Saxifraga sarmentosa* closes up on the slightest wind velocities, while *Hydrangea hortensis* remains open in the strongest wind.

(2) If one represents the transpiration of an organ for given time, conditions, and quiescent air as 1, air-movements may cause it to ascend to 20, or sink to 0·65. (3) The maximum influence causes an air-stream at right angles to the transpiring organ. (4) A sinking of the transpiration ensues when by rapid and complete closure of the stomata the entire intercellular transpiration ceases and the epidermal transpiration is very slight (*Saxifraga sarmentosa*).

(5) Transpiration is greatly increased by drying if the stomata of the organ remain open even in wind (*Hydrangea hortensis*). (6) With very vigorous epidermal transpiration there may even be a considerable increase, if the stomata are quickly closed (*Adiantum capillus-Veneris*). The air-movements were caused by a bladder or by rotation, and measured by an anemometer or by computing the rotations.

Literature of Transpiration.†—Dr. A. Burgerstein gives an epitome of all works and papers on this subject published between 1672 and 1886, in sixteen different languages. As many as 236 different publications are cited, with an abstract of the contents of each. They are arranged chronologically. The author believes the list to include every important paper on the subject.

(3) Irritability.

Movements of Irritation.‡—Herr J. Wortmann has investigated the cause of the sensitiveness of the unicellular sporangiophore of *Phycomyces*. That the geotropic and heliotropic curvatures of this cell are not due to changes in turgidity is clear, since every change in the hydrostatic pressure affects the entire wall equally, and the curvature can only be the result of changes in the capacity for growth of the cell-wall caused by the irritation of the protoplasm, and of consequent changes in its elasticity and extensibility. The special object of the present inquiry

* Biol. Centralbl., vii. (1888) pp. 667–8. SB. K. Akad. Wiss. Wien, Nov. 1887.
† Verhandl. K. K. Zool.-Bot. Gesell. Wien, xxxvii. (1887) pp. 691–782.
‡ Bot. Ztg., xlv. (1887) pp. 785–94, 801–12, 817–26, 833–43.

is to determine the nature and the causes of the sensitiveness to contact, the set of movements termed by Errera *haptotropism*.

The author found the sporangiophore of *Phycomyces* excessively sensitive to slight continuous contact, the heliotropic movements being comparatively very sluggish. A contact of from three to six minutes is sufficient in most cases to incite a decided curvature, concave on the side of contact; when the pressure ceases, the curvature may either remain or continue. This sensitiveness is limited to the growing region of the cell; in mature plants no curvature takes place. The strongest curvature is not, however, necessarily at the point of contact, but always at the point of most vigorous growth, but it must always commence at the exact point of contact. *Phycomyces* behaves, in fact, exactly like a growing tendril.

As in geotropic, heliotropic, and hydrotropic curvatures, so these haptotropic curvatures of *Phycomyces* are always accompanied by a peculiar change in the distribution of the protoplasm, which accumulates on the concave as contrasted with the convex side. This change commences as soon as the curvature begins, and when this ceases the protoplasm again assumes its uniform distribution. This accumulation of protoplasm on the concave side of the cell is unquestionably the result of an actual transfer from one side to the other; and it is always accompanied by an increase in the thickness of the cell-wall. The cell-wall may be more than twice as thick on the concave as on the convex side. This increase in thickness of the cell-wall is the cause of the curvature, increasing its elasticity and decreasing its extensibility. The cell-protoplasm behaves, in fact, like a free plasmodium until its motion is arrested by the cell-wall where it accumulates. This is followed by a change in the constitution of the cell-wall, and this again by the action of turgidity on the altered cell-wall.

Similar results, in their main features, were obtained with other unicellular organs, such as the cells of *Saprolegnia*, root-hairs, &c.

Passing now to the consideration of the corresponding phenomena in multicellular organs—roots, stems, nodes of grasses, leaf-stalks, tendrils, climbing stems, &c.—no such accumulation of protoplasm can be detected on the irritated side of the separate cells; the alternative that the entire multicellular organ acts like a single cell can be proved to be the correct one. On the concave side of the organs named, the cells are always found to contain more protoplasm than those on the convex side; and the same is true of roots which display geotropic curvatures; and the accumulation of protoplasm is in proportion to the degree of curvature.

This change in the distribution of the protoplasm in a multicellular organism can only take place by the transference of the protoplasm from cell to cell, and hence necessitates the assumption of a continuity of protoplasm throughout the organ, an assumption the correctness of which the author has amply demonstrated, both in the cortical and in the medullary parenchyma; this continuity is especially clearly seen in the growing points immediately behind the apex of the root. The irritation of the organ in question acts therefore not on a number of protoplasts, but on a single one capable of passing through the perforations in the cell-walls. Just as in unicellular organs, this accumulation of protoplasm is accompanied by an increase in the thickness of the cell-wall; and this thickening is so energetic that it is perfectly visible

to the naked eye in thin sections of stems of *Phaseolus multiflorus* that are allowed to lie for thirty-six or forty-eight hours in a horizontal position; a very great thickening of the cell-walls having taken place on the upper side, exposed to the irritation of direct sunlight in the whole of the cortical parenchyma, including the epidermal cells.

The author believes that these observations will throw great light on certain phenomena at present difficult of explanation, such as latent irritation and the secondary action.

Irritability of the Stamens of Echinocactus.* — Mr. T. Meehan notes the great irritability of the stamens of *Echinocactus ottonis*, a phenomenon already recorded in many species of *Opuntia* and allied genera.

(4) Chemical Changes (including Respiration and Fermentation).

Sources of the Nitrogen of Vegetation.† — Sir J. B. Lawes and Prof. J. H. Gilbert in this paper discuss the present position of the question of the sources of the nitrogen of vegetation, and also indicate some new lines of investigation which they are following up. In earlier papers, the authors had concluded that, excepting the small amount of combined nitrogen annually coming down in rain, and the minor aqueous deposits from the atmosphere, the source of the nitrogen of our crops was substantially the stores within the soil and subsoil, whether derived from previous accumulations, or from recent supplies by manure. More recently it has been shown that the amount of nitrogen as nitric acid in the soil was much less after the growth of a crop than under comparable conditions without a crop. After giving the details of numerous experiments performed by themselves and others, the authors conclude by stating that whether or not the lower organisms may be proved to have the power of bringing free nitrogen into combination, it at any rate would not be inconsistent with well-established facts, were it found that the lower serve the higher by bringing into an available condition the large stores of combined nitrogen already existing, but in a comparatively inert state, in our soils and subsoils.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Conversion of Fertile into Sterile Fronds.‡ — Herr K. Goebel has succeeded in converting the fertile sporophylls of *Onoclea Struthiopteris* into barren green fronds, or rather in hindering the metamorphosis of the latter into the former. This fern is distinguished by having three distinct kinds of leaf, the fertile fronds, the barren fronds, and "cataphyllary leaves" which appear not only on the stolons, but also as bud-scales inclosing the hibernating terminal bud. These are all modifications of ordinary foliage leaves. The barren and fertile fronds differ from one another in many important points of structure, as well as in the time of their appearance, the former unfolding at the commencement, the latter at the close of the period of vegetation. If at the end of June all the barren fronds are removed, the fronds which subsequently unfold will display all kinds of transitional stages between the two forms, their

* Proc. Acad. Sci. Philad., 1887, p. 332.
† Proc. Roy. Soc., xliii. (1887) pp. 108–16.
‡ Ber. Deutsch. Bot. Gesell. (Gen.-Versamml. Heft), v. (1887) pp. lxix.–lxxiv.

conversion into fertile fronds being more or less impeded by the removal of the barren fronds. Similar intermediate forms are also not uncommon in nature, and correspond to the transition between barren and fertile stems in some species of *Equisetum*.

Formation of Gemmæ in Trichomanes.* — Prof. F. O. Bower describes the formation of peculiar outgrowths on the frond of *Trichomanes alatum*. The first kind were ribbon-shaped prolongations of the laciniæ of the frond, resembling prothallia in structure, and bearing spindle-shaped gemmæ seated on sterigmata. The second were long protonema-like filaments widening ultimately into flat prothallium-like expansions, which also bore stalked gemmæ. Although no antheridia or archegonia were observed, Prof. Bower believes these structures to be prothallia produced by apospory.

Enterosora.†—In his description of the plants obtained by Mr. Im Thurn in his expedition in 1884 to Roraima, British Guiana, Mr. J. G. Baker describes under this name a new genus of ferns with the habit of *Gymnogramme*, but displaying a singular peculiarity in the position of the sporangia. They are seated at the base of globular chambers in the under surface of the leaf which open only by a very narrow fissure, so that they are almost entirely hidden.

Life-history of Lycopodium.‡—Dr. M. Treub suggests that a more natural classification than any hitherto proposed of the species of *Lycopodium* may be based on the structure of the oophyte generation. He points out that there are three distinct types of prothallium in the genus, viz.:—(1) the *annotinum* type (not sufficiently known); (2) the *cernuum* type, and (3) the *Phlegmaria* type. He has now studied the structure of the oophyte generation in four fresh species of *Lycopodium*.

In *L. carinatum* the prothallium appears exactly to resemble that of *L. Phlegmaria*; and in *L. Hippuris* and *L. nummulariæfolium* to be of the same type but much larger and thicker; while in another lycopod raised from spores, probably a new species, the prothallium is of the *cernuum* type, though differing considerably from that of that species.

In *L. cernuum* the root-tops change into propagating organs of a remarkable form. These root-gemmæ or bulbs produce, on germinating, young plants very much like those which come forth from prothallia.

Prothallium of Equisetum.§—Dr. O. Buchtien has made a careful series of observations on the development of the prothallium of several species of *Equisetum*, especially *E. arvense*, *pratense*, and *sylvaticum*.

One of the chief points brought out in these investigations is the difference in the development of the male and female prothallia. In the male prothallia septa in two directions, transverse and longitudinal, continue to arise, but very few lobes are formed, and, with rare exceptions, these always remain sterile. The first antheridium is formed about four weeks after the germination of the spore. The mature male prothallium is smaller than the female, and of a yellower-green colour. In the female prothallium, the central portion soon becomes several layers of cells in thickness, by tangential as well as transverse and longitudinal division-walls; a few cells, distinguished by their

* Ann. of Bot., i. (1887) pp. 183–4.
† Trans. Linn. Soc. Lond.—Bot., ii. (1887) p. 294 (1 pl.).
‡ Ann. of Bot., i. (1887) pp. 119–23. Cf. this Journal, 1887, p. 621.
§ Uhlworm and Haenlein's Biblioth. Bot., Heft viii., 49 pp. and 6 pls., 1887.

abundant protoplasm, swell out on the shaded side of this portion and grow into a lobe, one cell of which developes into an archegonium. The ultimate position of the archegonium is between two lobes which inclose it like a funnel and serve to hold the moisture which is essential to its impregnation. From experiments made by the author, it would appear that an abundant supply of nutriment is favourable to the formation of female, a scanty supply to the formation of male prothallia.

In the mode of formation of the spermatozoids the author's conclusions differ somewhat from those of previous observers. He states that in none of the higher cryptogams does a disappearance of the nucleus of the mother-cell take place; the nucleus, on the contrary, developes directly into the spermatozoid, the cilia being formed from the cell-protoplasm. The bladder which is so frequently attached to the posterior part of the spermatozoid, he regards as the remains of the mother-cell.

The structure of the prothallium appears to the author to indicate that the Equisetaceæ are more nearly allied to the Lycopodiaceæ than to the Filices.

Leaves of Sigillaria and Lepidodendron.*—M. B. Renault states a number of well-preserved leaves of Sigillaria have been met with in a railway cutting near Dracy-Saint-Loup. They are long and rigid, and in transverse sections are subtriangular. In the centre of the section is a single vascular bundle. The outermost layer consists of an epidermis composed of thickened rectangular cells.

The transverse section of the leaves of *Lepidodendron selaginoides* is rhomboidal in shape, the greater diameter being horizontal. In the centre of the section is a single vascular bundle; between the bundles and the edges of the leaf are two round cavities. Occasionally these cavities, which are only to be found at the base of the leaf, are filled by a group of large cells. The author suggests that the destruction of these cells may have formed a secretory canal.

Muscineæ.

Absorption of Water and its Relation to the Constitution of the Cell-wall in Mosses.†—Mr. J. R. Vaizey chose *Polytrichum commune* for his observations on the absorption of water in mosses. He obtained stems of this species some 15–20 cm. in length, and placed them with their cut ends in water, about half an inch being below the surface. Placed in a cool room with a dry atmosphere, in less than half an hour all the leaves except the last half-dozen nearest the water were withered. The author then treated sections from various parts of the plant with different reagents. From the reactions obtained it is obvious that the epidermis of the seta, apophysis, and sporangium is strongly cuticularized, and that there is on the outside of the epidermis a distinct cuticle.

The hypodermal sterome appears from the reaction to contain both lignin and cutin, and consequently must be regarded as suberized. From the condition of the cell-walls, the leaves are the chief organ for absorbing water, as well as for carrying on assimilation in the oophyte.

Peristome of Mosses.‡—M. Philibert states that great differences exist in the structure of the external peristome in mosses. In a small number of families (i. e. Nematodonteæ) it is composed of filaments

* Comptes Rendus, cv. (1887) pp. 1087–9. † Ann. of Bot., i. (1887) pp. 147–52.
‡ Rev. Bryol., xiv. (1887) pp. 81–90. Cf. this Journal, 1887 p. 275.

without transverse articulations; but in the Arthrodonteæ the teeth are articulated.

An internal peristome has never been observed in the Aplolepideæ; it is present, however, in nearly all the families of the Diplolepideæ. The internal peristome is composed of two membranous laminæ, but the plates composing each lamina are thinner, softer, more difficult to separate, and often more difficult to distinguish, than is the case with the corresponding plates in the external peristome. In some species, however, the lines bordering the plates form two rosettes which are easily distinguishable. The plates which are placed on the dorsal face of the external peristome correspond to the ventral plates of the teeth; they are the same in number, and are exactly opposite to the latter. There is thus at each stage of elevation of the internal peristome a circle of sixteen plates, which originate in the same layer of cells as the ventral plates of the external peristome; they represent the internal vertical divisions of these cells, the ventral plates of the teeth being the external divisions. The horizontal divisions are represented by lamellæ which project at the articulations. In certain species these lamellæ of the teeth adhere to the internal peristome, and the primitive cells remain entire, except on their lateral faces where a thickening of the divisions occasionally takes place. The internal peristomial membrane, which remains undivided in its lower part, shows a dorsal network formed of sixteen vertical equidistant lines, and numerous horizontal lines which are parallel and very near to one another. The author takes *Mnium orthorrhynchum* as an example of the species in which the two networks are easily distinguishable, and describes their structure somewhat in detail. If a transverse section be made of a young capsule of *M. orthorrhynchum* a little above the point where the two peristomes originate, we see them not as two concentric circles, but as sixteen semi-cylindrical cavities. In the interior of these cavities the ventral lamellæ of the teeth arise horizontally in the form of semi-elliptical plates, without touching the membrane that surrounds them.

We have here then the sixteen series of primitive cells from which the two peristomes are formed; but on account of the unequal thickening of their different elements the two systems of plates of which they are composed cease to adhere together, and they become free.

Hybrid Mosses.*— Dr. C. Sanio records the occurrence of hybrid mosses in the section Harpidieæ, viz. between *Hypnum fluitans* and *aduncum*, and between *H. lycopodioides* and *fluitans*, giving rise to a great variety of forms. In only one of these did the vegetative organs present a true species; in the remainder the hybrid character was manifested, especially in the vegetative portions, while the fructification was very little or not at all altered.

Distribution of Hepaticæ.†—Dr. C. Massalongo classifies the Italian species of Hepaticæ; first, according to their habitat, viz. (1) aquatic (*Riccia fluitans* and *natans*); (2) calcicolous; (3) silicicolous; (4) saprophytic; (5) hygrophilous; (6) xerophilous; (7) indifferent. Secondly, they are classified according to altitude; and thirdly, geographically, according to the other countries of Europe in which they are found. A useful epitome of the structure of the various organs is appended.

* Hedwigia, xxvi. (1887) pp. 194–214.

† Atti Congr. Naz. Bot. Critt. Parma, Sept. 1887, pp. 13–27.

Algæ.

Phycophæin.*—Herr F. Schütt has separated this pigment from others with which it is associated in a number of brown and olive sea-weeds from the North Sea:—*Fucus vesiculosus*, *F. serratus*, *Desmarestia aculeata*, *Ozothallia nodosa*, and others. It can be completely extracted from the living plant by triturating and treating with hot water. The absorption-spectrum of phycophæin presents no strongly marked characters. It exhibits no characteristic bands, but a regular increase of absorption from the red towards the blue end of the spectrum. The pigment appears to be identical in the species examined; but that from *Fucus vesiculosus* showed a slightly divergent absorption-spectrum, and slight difference also in its chemical reactions from that obtained from the other species.

Development of the Thallus of certain Algæ.†—According to M. F. Debray, the statement that there is in the thallus of *Chyloeladia*, *Champia*, and *Lomentaria*, a single apical cell, is incorrect. The growing point situated at the end of the branches is composed of several independent generating cells placed round the summit. From each of these is formed, by repeated transverse septa, a longitudinal row, each cell of which divides again tangentially into a cortical cell and one lying at a greater depth.

Sieve-tubes in the Laminarieæ.‡—Mr. F. W. Oliver describes the occurrence of true sieve-tubes with sieve-plates in the genera *Nereocystis* and *Macrocystis*.

In a transverse section of the stem of any species of Laminarieæ, the central strand consists of a meshwork of hyphæ imbedded in mucilage, among which are a number of narrow tubes, without septa, except at certain points where the hypha is swollen up spherically. Across this enlarged portion runs a septum which is considered to represent a sieve-plate. These tubes are known as sieve-hyphæ or *trumpet-hyphæ*, and are universal in all genera of Laminarieæ. In *Macrocystis* and *Nereocystis*, surrounding this central strand of hyphæ, is a zone of tubes with thick walls, which are true *sieve-tubes*, and resemble to an extraordinary degree those of *Cucurbita*. Callus occurs in both the trumpet-hyphæ and the sieve-tubes of these two genera; but not, as a general rule, in the other genera of Laminarieæ.

Between the trumpet-hyphæ and the zone of sieve-tubes there run strands of ordinary hyphal tissue. In the trumpet-hyphæ, at any rate, the author believes that the callus is formed directly from the cell-wall. In the sieve-tubes sieve-plates occur, not only in the septa, but also on the vertical cell-walls. The callus formation takes place on both kinds of plate, and ultimately completely obliterates the perforations. It is found at no other part of the wall except the sieve-plates, which is not the case with the trumpet-hyphæ. The formation of this callus takes place at an early period in the history of the sieve-tubes. Its properties agree altogether with those of the callus in the sieve-tubes of Phanerogams.

The author points out the analogy between the occurrence of sieve-

* Ber. Deutsch. Bot. Gesell., v. (1887) pp. 259-74 (1 pl.).

† Bull. Scient. Départ. Nord, ix., 16 pp. and 4 figs. See Bull. Soc. Bot. France, xxxiv. (1887), Rev. Bibl., p. 160.

‡ Ann. of Bot., i. (1887) pp. 95–117 (2 pls.).

tubes in *Macrocystis* and *Nereocystis*, in which the stem attains an enormous length without any corresponding increase in thickness, and in a weak climbing stem like *Cucurbita*; while in the allied genus *Lessonia*, which has a very stout and erect stem with long-continued secondary growth in thickness, they are altogether wanting.

Development of Confervaceæ.*—Herr G. Lagerheim has investigated the life-history of *Conferva bombycina* and of some species of *Microspora*, belonging to the Confervaceæ, under which family he includes the genera *Binuclearia*, *Chætomorpha*, *Conferva*, *Hormiscia*, *Microspora*, *Rhizoclonium*, *Ulothrix*, and *Ulospora*.

The cells of *Conferva bombycina* contain several small disc-shaped parietal chromatophores without pyrenoids or starch, and a single nucleus. From each cell may be produced either one or two zoospores; in the latter case the cell-contents are first divided in two by a colourless septum of protoplasm; the cuticle of the cell is converted into mucilage before the escape of the zoospores. These are elongated ovate bodies provided with a single small disc-shaped chromatophore and a single cilium, but no red pigment-spot; their movement is not dissimilar to that of a *Euglena*. The young *Conferva*-filament springing from it has at first the appearance of a *Characium*. These correspond to the megazoospores of Wille, two different kinds not having been observed in this species. They very closely resemble the uniciliated megazoospores of *Botrydium*.

Resting-cells are also formed in this species, either one, two, or four proceeding from a single cell of the filament, by the cell-contents rounding off, and inclosing themselves with a cell-wall while still within the parent-cell. They correspond, therefore, to the aplanospores of Wille. They hibernate within the dead cells of the parent-filament, and germinate in the spring. Resting swarm-cells are also formed in the same way. These escape from the parent-cells without any cellulose-coat, move about with an amœboid motion, finally come to rest, and coat themselves with a wall of cellulose. Whether these, on germination, produce zoospores, has not been observed.

The formation of the megazoospores of *Microspora* was observed in *M. Willeana* n. sp. and *stagnorum*. The parent-cells contain several ribbon-shaped chromatophores and starch, but no pyrenoids, and a single nucleus. The zoospores are of two kinds. The megazoospores are produced either singly or two in each parent-cell, their size varying between 10 and 14 μ; they are biciliated; they have no pigment-spot; the chlorophyll is moderately uniformly distributed over the periphery, and contains starch-grains. They appear to pass through a period of rest before germinating. Megazoospores are occasionally produced with four cilia; they probably germinate in the same way. Resting-spores and resting swarm-spores of the same kind as those in *Conferva bombycina* were also observed in *M. Willeana*.

The author considers the above characters quite sufficient to keep apart the genera *Conferva* and *Microspora*, though several species usually placed under the former must be transferred to the latter genus. He also regards them without doubt as fully developed algæ, and not as stages of development of higher algæ.

* Ber. Deutsch. Bot. Gesell., v. (1887) pp. 409–17.

Algological Studies.*—Dr. A. Hansgirg has collected into a volume the results of observations already published elsewhere on the following points, viz. :—(1) The structure and phenomena of motion of the Oscillariaceæ; (2) the polymorphism of algæ; (3) the classification of some fresh-water algæ; (4) the algæ of Bohemia; (5) alga-like protonemata of mosses. The following additional observations are made :—

The genus *Glaucothrix* Krch. should be united to *Plectonema* among Cyanophyceæ.

The genus *Allogonium* is identified with *Asterocystis* Gobi and *Chroodactylon* Hansg., and the name must take precedence of all other synonyms.

Xenococcus (*Kerneri*) is distinguished by marked generic characters from most other Chamæsiphonaceæ and Chroococcaceæ.

The blue-green swarm-cells described by Ehrenberg, Perty, Stein, Schmitz, and Zopf, and previously regarded by the author as derived from various Schizophyceæ, he now treats as a separate group of Phycochromaceæ under the name *Cryptoglænaceæ*.

There is a genetic connection between the Eugleneæ, which are reckoned among the Flagellatæ and the Phycochromaceæ, especially the Oscillariaceæ.

The *Cylindrocapsa* found by Hansgirg in the botanical garden at Prag is apparently a variety of *C. geminella* Wolle. The genus belongs to the oogamous Confervoideæ, but must be separated from *Sphæroplea*, and established as the sole representative hitherto known of a new family.

Ulvella lens is nearly related to *Enteromorpha* and *Ulva*, and appears to be a protonema-like structure of these Ulvaceæ.

The author is unable at present to assign their exact systematic position to *Protoderma viride* Ktz. and *Hormospora* Bréb.

Sphæroplea.†—M. N. W. P. Rauwenhoff has afresh examined the structure and development of this very rare alga. The comparative length and breadth of the cells he finds to vary to an extraordinary degree; sometimes the former will hardly exceed the latter, while in other cases it may be as much as ninety times as great. The plant is monœcious, and the number of oogonia and antheridia, as a rule, very nearly the same. Sometimes alternate cells will be transformed into the two different kinds of organ respectively. The author observed plants consisting only of two cells, one of each kind. The fertilized oospores generally hibernate within the parent-cells, the contents having changed to a brick-red colour, and it is only in the spring that there escape from each oospore three or four zoospores. The usual size of the oospores is about 0·02 mm.; the outer wall is strongly cuticularized and verrucose. As each zoospore escapes from the oospore, forcing itself through an orifice in its thick wall, it changes its form from ellipsoidal to vermiform; after its escape it again becomes pyriform or fusiform, and is furnished with two cilia. This developes directly into the young alga, consisting at first of a single fusiform cell with both extremities elongated into a flagelliform point.

After the unicellular filament of *Sphæroplea* has obtained a certain

* Hansgirg, A., Physiol. u. Algol. Studien, 187 pp. and 4 pls., Prag, 1887. See Bot. Centralbl., xxxii. (1887) p. 226. Cf. this Journal, 1884, p. 435; 1885, pp. 495, 684, 1037; 1887, pp. 125, 623.

† Arch. Néerl. Sci. Exact. et Nat., xxii. (1887) pp. 91–144 (2 pls.). Cf. this Journal, 1883, p. 888.

length, a transverse wall makes its appearance, which is then followed by others. These transverse walls are of great thickness, often ten times as thick as the lateral walls; and their surface is irregularly wavy, giving them great refringency. For a time there is not unfrequently a circular orifice in the middle of these "beams." In addition to these there are "irregular" septa, consisting simply of excrescences of cellulose from the lateral and longitudinal walls. While the outer walls grow by intussusception, the transverse walls grow by the apposition of layers of cellulose. The orifices in the walls of both antheridia and oogones, through which the spermatozoids reach the oosphere, appear to be formed during the development of these organs.

On the point of the presence of a nucleus in the cells of *Sphæroplea*, Rauwenhoff corrects his former statement, and now asserts that, by the use of the proper reagents, a larger number of very small nuclei can be detected in the mature cell. The very young plant contains a single nucleus with a distinct nucleolus; at a later period two may be seen, and then the number rapidly increases, probably by division.

Ulothrix crenulata.*—From an examination of this alga, found growing on the trunks of trees, M. E. de Wildeman confirms the observations of Gay † on the formation of cysts in the Chlorosporeæ. A gradual transformation of the cells of this species takes place into a form indistinguishable from *Pleurococcus*, exceedingly similar to the corresponding changes in *U. radicans*. The form known as *Schizogonium* may probably be regarded as another phase in the life-history of the same organism.

Alga epiphytic on a Tortoise.‡—Mr. M. C. Potter describes an alga, previously detected by Peter,§ and named by him *Dermatophyton radicans*, growing principally on the dorsal surface of the carapace of the water-tortoise, *Clemmys caspica*, where it forms irregular roundish dark-green patches often about 1/4 of an inch in diameter. No sexual reproduction was observed, the alga being propagated by means of zoospores formed from the outermost layers of cells, without conjugation. The author considers it probable that it must be ranked under the Ulvaceæ.

Formation of Auxospores in Diatoms.‖—Herr F. Schütt states that in the genera *Rhizosolenia*, *Orthosira*, *Melosira*, and other forms nearly related, he has been able to detect no indication of any process of sexual reproduction. In *Cocconema*, *Frustulia*, and most Naviculaceæ, two naked cells, separated by gelatinous layers, lie side by side, but do not unite, each of them becoming an auxospore. In *Himantidium* (*Eunotia*) the two naked juxtaposed cells unite into a single auxospore; while in *Epithemia* the two cells divide transversely, the two halves of each cell, which lie opposite to one another, uniting into an auxospore; each auxospore therefore including one-half the contents of the two cells.

Fungi.

New Forms of Mycorhiza.¶—Herr B. Frank states that he has observed the following distinct colours in mycorhiza-filaments on the

* CR. Soc. R. Bot. Belg., 1887, pp. 119–23. † See this Journal, 1887, p. 277.
‡ Journ. Linn. Soc. Lond.—Bot., xxiv. (1887) pp. 251–4 (1 pl.).
§ See this Journal, 1887, p. 123.
‖ Biol. Centralbl., vi. (1887). Cf. this Journal, 1886, p. 832.
¶ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 395–409 (1 pl.). Cf. this Journal, 1886, p. 113.

roots of beeches and on *Monotropa* growing beneath them, viz.:—(1) Chalk-white, in which there is no true pigment, but the colour is caused by a coating of minute crystals of calcium oxalate; (2) pale pink, both on the beech and on *Monotropa;* (3) pale violet; (4) orange; (5) golden yellow; (6) reddish brown. With regard to the degree of connection of the parasitic fungus with the root, he distinguished between *ectotropic* mycorhiza, in which the fungus clothes the root only with an external coating, and *endotropic*, in which it attacks the cells of the root itself.

Of ectotropic mycorhiza far the most frequent is the ordinary coral-like form. A second form occurs with long branches and root-hair-like lateral organs. This has been observed on beech-roots, and completely resembles externally ordinary roots not attacked by mycorhiza. The external fungus-coating has here an extraordinary thickness, equal to half the radius of the root itself, and consists of ordinary pseudo-parenchymatous elements, the hyphæ closely united together into parallel bands. A third form of ectotropic mycorhiza occurs on the roots of *Pinus Pinaster* from the Cape. The roots are covered with patent hair-like filaments resembling coarse root-hairs. These are very short and slender branches of the root so densely covered with mycorhiza that the coating may even be as thick as the diameter of the root-branch.

Of endotropic mycorhizas, one of the most remarkable forms is that of the roots of *Ericaceæ* (as well as *Empetrum*).* The roots infested by it are distinguished by their very small diameter, from 0·03 to 0·07 mm., their very simple internal structure, and the entire absence of root-hairs. The epidermis forms the principal part of the root, and its cells are filled with a colourless mass consisting of the mycorhiza-hyphæ, which constitute a pseudo-parenchymatous tissue somewhat of the nature of a sclerotium, but distinguished by the extreme minuteness of its elements. The root-cap is, in these cases, reduced to a rudimentary condition. The mycorhiza was not found on the roots of other heath and marsh-plants growing in similar situations.

Another form of endotropic mycorhiza is that of the roots and rhizomes of Orchideæ† occurring in the interior of the cortical parenchymatous cells in the form of a ball of interwoven hyphæ, which pierce through the walls of the cells. It occurs invariably in non-chlorophyllous orchids, such as *Neottia nidus-avis*, *Corallorhiza innata*, and *Epipogon Gmelini*, and is essential to the absorption by the roots of nutrient substances. The nature of the symbiosis is here one of mutual assistance; the protoplasmic body of the cell of the root and that of the fungus contained in it carry on their existence side by side, without the former being affected parasitically by the latter or its vital processes injured.

Abnormal Fructification of Agaricus procerus.‡—Dr. R. von Wettstein describes a specimen of this fungus in which three additional pilei sprang on the underside of the primary one from between the lamellæ. All were fully developed.

Sexuality of Ustilagineæ.§—Sig. F. Morini has made some observations on the question of the sexuality of Ustilagineæ. In a previous paper he had regarded the fusion of the conidia as an asexual copulation,

* See this Journal, *ante*, p. 86.
† See this Journal, 1886, p. 1029.
‡ Oesterr. Bot. Zeitschr., xxxvii. (1887) pp. 414–5 (1 fig.).
§ Mem. Accad. Sci. Bologna, vi. (1886) pp. 283-90.

and had noted the influence exercised by changes in the nutritive condition of the substratum, the evolution of each conidium, whether free or anastomosed, and the absence of any direct advantage in the sexual process. In water, whether rain, spring, or distilled, the phenomena of fusion were never observed. In decoction of *Carex* leaves, and in other nutritive solutions, the fusion was observed, the less rapidly the more nutritive the fluid. Three types of union were noted: apposition by the apices, apposition at an angle, apposition in H-form. In the fusion of the conidia of *Tolyposporium* an essential condition is the progressive diminution of the nutritive capacity of the substratum.

Passing to a review of the phenomena of fusion in Ustilagineæ generally, the author notes two forms in which it occurs in water—(*a*) fusion of spores, (*b*) fusion of the points of the germinal tube of the spores. In the latter case (1) two segments of the same tube may be apposed; or (2) two segments of the same filament, separated by one or more points, may unite; or (3) two segments of distinct tubes may come together. After discussing these, Sig. Morini describes the germination of the spores in a nutritive solution. In *Tilletia* sp., and in *Entyloma* the spores do not germinate; in a second series (*U. Maydis*, *U. Vaillantii*, &c.) they pass through the usual saprophytic phases, and the conidia remain always free; in *U. Betonicæ*, *U. longissima*, and *Tolyposporium cocconii* fusion is observed when the nutritive medium begins to be exhausted. After discussing these facts, and corroborating his previously expressed opinion, the author emphasizes that those who would insist on sexuality have to explain an extraordinary complication of apogamy, parthenogenesis, isogamy, incipient heterogamy, and useless sterile sexuality. He gives other reasons for maintaining that the fusion of conidia in Ustilagineæ is an asexual conjugation.

Germination of the Spores in Ustilago.*—Following up his previous researches, Sig. F. Morini has made a special study of the germination of the spores in *Ustilago Vaillantii*. His general conclusions are as follows:—(1) In spring water, filaments are formed, more or less long, generally somewhat branched; each spore usually germinates from two opposite points; (2) in rain water, the direct formation of filaments is much more reduced; short tubes are formed, but not abundantly, and these finally give rise to short filaments; (3) in nutritive solutions, the spores form simple tubes, frequently forming a short branch, which reproduce by budding; when the medium begins to be exhausted longer filaments are formed, more frequently branched, and separating off terminal portions as ovoid cells; these new elements, somewhat like conidia, occur only on a restricted number of filaments, and have no special disposition on the hypha; (4) finally, when the nutritive medium is exhausted, a double formative activity is exhibited, destined to preserve the fungus in a latent state; on the one hand, there is a formation analogous to the chlamydospores of Mucorini; on the other hand, a process similar to the budding prolification of the spores and of the mycelial tubes of some Mucorini, and to the gemmiferous segmentation of some micronematous Hyphomycetes.

Tremella fimetaria.†—M. E. Boudier states that since Schumacher in 1881 described *Tremella fimetaria*, this species has not been found

* Mem. Accad. Sci. Bologna, vi. (1886) pp. 689-94 (1 pl.).
† Morot's Journ. Bot., i. (1887) pp. 330-3.

by any mycologist. The author, however, had the good fortune to find it early in last November, on horse dung, in the forest of Montmorency. It formed little tubercules of a vinous red colour, which were 1 to 4 mm. in diameter and 1 to 2 mm. in thickness. They resemble little groups of *Ascophanus carneus*. These tubercules were hard and not gelatinous; they were formed of septated and ramifying filaments, which were 2 to 3 μ in diameter. The spores were colourless, ovoid-oblong, slightly fusiform, and finely granular in the interior. The fructification is not that of the true *Tremellæ*, but of the genus *Helicobasidium*. This, then, will form a new species in that genus under the name *Helicobasidium fimetarium*.

New Genera of Ascomycetes, Oleina and Podocapsa.*—M. P. Van Tieghem describes two new genera of Ascomycetes, which he states are especially interesting, as they form their asci without any phenomena which may be interpreted as an expression of sexuality.

Oleina was discovered when making researches on the vegetation occurring in oil. The thallus is composed of straight filaments, septated and branched, and projecting here and there into the oil. The filaments resemble those found in other Ascomycetes, notably *Aspergillus clavatus*. Here and there towards the edge of the cultures certain branches are septated more closely, and the short cells thus separated become of an ovoid or spherical form. These are the cysts, and are analogous to those found among the Mucorini, where they are called chlamydospores. When the thallus has fully developed it produces asci, varying in position according to the species.

Podocapsa was observed as a singular production on the surface of the sporangiferous filaments of a *Mucor*. Each individual was composed of an ovoid, polysporous ascus, borne on a cylindrical pedicel, and attached to the *Mucor* by three or four cells at the base. The whole was not more than 0·04 mm. in height. The ascus is separated from the pedicel by a transverse wall, and incloses 32 colourless fusiform spores, 8 μ long by 3 μ broad, which are agglomerated together for some time by a gelatinous substance.

Asci of Penicillium crustaceum.†— Herr H. Zukal does not agree with Brefeld in his statement that the sclerotia of this fungus are the result of an act of impregnation. He finds the mode of their formation to be altogether analogous to that of the sclerotia of *Aspergillus*, from the vegetative intertwining of perfectly equivalent hyphæ. After remaining at rest for a period of four or five weeks, the central portion of the sclerotium degenerates and becomes converted into mucilage. From the inner wall of the hollow thus formed proceeded delicate hyphæ, which in eight or nine weeks produced the asci.

Formation of Sporangia and Spores in the Saprolegnieæ.‡—Herr W. Rothert has examined the mode of development of the sporangia in this order, especially in *Saprolegnia Thureti* and *monoica*. The results differ in some points from those attained by Strasburger and Büsgen.

The earlier stages in the separation of the sporangium from the sporangiophore are described in detail. Before the differentiation of the

* Morot's Journ. Bot. i. (1887) pp. 289–96 (2 figs.).

† SB. K. K. Zool.-Bot. Gesell. Wien, xxxvii. (1887) p. 66.

‡ SB. Krak. Akad. Wiss., xvii. (1887) pp. 1–67 (1 pl.). Bot. Centralbl., xxxii. (1887) p. 322.

spores the protoplasm may be distributed in the sporangium in three different ways, viz. (1) the whole of the sporangium is filled with protoplasm; (2) the protoplasm forms a parietal layer of the same thickness as the height of the subsequent layer of spores; (3) the protoplasm forms a parietal layer of variable thickness, but always less than the height of the subsequent layer of spores. Of these the second case is the commonest. Immediately before the differentiation of the spores the appendage is formed, usually at the apex of the sporangium. In the earlier stages of the differentiation of the spores, the entire parietal layer of protoplasm forms itself into a network, consisting of polyhedral portions of nearly uniform size. These are separated by narrow, deep vertical indentations, but are not yet differentiated into spores. Where the protoplasm occupies the whole of the sporangium, the latter is entirely filled up by this network. After this condition has lasted for a few minutes, the rudiments of the spores swell up so as to come into close contact with one another, small vacuoles are formed, which rapidly increase in size and then suddenly disappear, and the spores then become rounded off and distinctly differentiated. The formation of the cilia was distinctly observed, making their appearance as short hairs with slow oscillating movement, and then growing rapidly in length, their oscillations increasing at the same time in rapidity. The spores now exhibit a vibrating movement, which assumes a more lively character shortly before their escape. About the time that the cilia are being formed, a very peculiar process takes place. At certain spots warts are formed on the spores, which gradually elongate, and finally become separated as lumps of protoplasm of variable sizes, often one-third the diameter of the spore. These move about for a time with a dancing motion, and then become absorbed again into the same spore from which they sprang, without apparently producing any change in it. If not again taken up, others are formed in the same way; and this lasts for some minutes. The spores escape in succession one after another, the first being ejected with some violence.

The process, as described above, is essentially the same also in other species of *Saprolegnia*, in *Achlya polyandra* and *oblongata*, *Dictyuchus clavatus* and *Leptomitus lacteus*. Notwithstanding statements to the contrary, the mode of formation of the sporangia in *Aphanomyces* is also essentially the same as that in the other genera of the family.

Herr Rothert also investigated the mode of formation of the oogonia, and found it to agree in essential points with that of the sporangia, and even in many small details. The formation of the parietal layer of protoplasm, and of the network composed of the rudiments of "spores" [oospheres], the mode of separation of the "spores," and other details, are again repeated in the development of the oogonia. The ordinary oogonia with few "spores" correspond to the sporangia with only a parietal layer of protoplasm, the less common ones with many "spores" to the normal sporangia entirely filled with protoplasm.

Infection of a Frog-tadpole by Saprolegnia ferax.*—Prof. J. B. Schnetzler had under observation two tadpoles; towards the end of last June, a fly (*Sarcophaga carnaria*) was placed with one of them. After death the body of the fly became covered with filaments of *Saprolegnia*

* Ann. and Mag. Nat. Hist., i. (1886) pp. 162–3 (Séance Soc. Vaud. Sci. Nat., July 6, 1887).

ferax, and the tadpole, which had hitherto been lively, soon became more sluggish in its movements; its body quickly became covered with filaments of *Saprolegnia*, and within two days after infection it died. The protoplasm of the filaments of the parasite on the body of the fly was found to be transformed into thousands of zoospores, which, by means of their two cilia rapidly diffused themselves through the water. This observation shows that a single dead fly may become the focus of infection of a large number of aquatic animals. The whole surface of the tadpole was covered with *Saprolegnia*, so that death must have been produced by the suppression of the action of the skin. The tadpole in the other vessel was not affected.

Elaphomyces.*—Drs. M. Reess and C. Fisch discuss the physiological relationship of this fungus to the roots of fir-trees, on which it is usually found, and contribute some additional knowledge to its life-history.

The authors regard the fungus as a true parasite on the roots of fir-trees. It is never found at any great distance from them, and all attempts failed to induce the spores to germinate either in the soil or in nutrient solutions. It attacks only the primary root, which it completely envelopes without apparently injuring it; the secondary roots pierce through this envelope and are not attacked by it; but the authors were unable to determine the mode in which the root obtains its nutriment from the soil, or whether there is any true symbiosis between it and the fungus.

The development of the receptacle is described especially in *Elaphomyces granulatus* and *variegatus*, which agree in essential points. The rudiment of the receptacle consists of a ball of mycelium with a number of intercellular spaces filled with air. A central hyaline nucleus is then differentiated from the surrounding slightly yellowish outer layer, which developes into pseudo-parenchyma, and is known as the "cortex vittadinis," while the central mass becomes the true peridium with its ascogenous tissue. The ascogenous hyphæ do not spring from the primary hyphæ of this tissue, but from special shoots proceeding from the hyphal tissue which clothes the interior of the periderm, and push themselves between the loose tissue of the gleba. The mature fructification consists of three distinct portions, cortex, peridium, and gleba. The asci originate as club-shaped or conical swellings on terminal or lateral branches of the ascogenous hyphæ, and are distinguished from all asci hitherto known by the fact that the septum which separates them from their supporting filament does not make its appearance till a comparatively late period, even after the young spores have begun to be formed. The number of spores in an ascus varies between 1 and 8. The cells of the cortex develope at particular points into the projecting warts which characterize the mature fructification.

Cabbage-Hernia.†—Dr. J. Brunchorst discusses the problem of the best way of obviating the loss caused by the fungoid ravages of *Plasmodiophora Brassicæ* among cabbages. It seems useful to change the stock, but the young plants are often infected in their seed-beds, and the disease is as bad as ever. He has therefore been led to experiment with bisulphide of carbon as a disinfecting agent for the soil; and his results, of which the statistics are given, have been most successful.

* Uhlworm and Haenlein's Bibl. Bot., Heft vii., 24 pp. and 1 pl., 1887.
† Bergens Mus. Aarsberetning for 1886 (1887) pp. 227–31.

Potato Fungus.*—Herr J. Brunchorst has investigated the conditions of a common disease of potato tubers, which is known by the names "skurv," "schorf," "grind," &c., and which seems most likely to occur on soil where potatoes have not for long, or ever before, been planted. The disease has been usually referred to something in the soil, but the author maintains that it is due to a parasitic fungus. It is a myxomycete nearly allied to *Plasmodiophora*, and it is proposed to designate the genus and species *Spongospora Solani*. The brown crusts or spots which cover the tubers are due to knots or aggregations produced by the fungus, and are covered by the normal rind of the potato. Details as to the nature of these fungoid growths, the time and conditions of their occurrence, are communicated.

Taphrina.†—Mr. B. L. Robinson has recently studied a number of American and European species of the genus *Taphrina*. The species combined by Sadebeck, in 1883, into a single genus, were formerly classed in three closely related genera, *Taphrina* Fries, *Ascomyces* Mont. et Desm., and *Exoascus* Fuckel. The presence of a *Taphrina* is manifested in the host in one or more of several ways, namely, by the occurrence on the leaves of roundish or irregular blotches, by a curling or crisping of the leaves, by a swelling out of the softer parts of the leaves between the nerves, by deformity of the fruit, and lastly, by the swelling and distortion of the twigs and young branches.

The author appends to the paper a synopsis of the American species examined. The primary divisions being (1) Mycelium penetrating intercellularly the inner tissues of the host; and (2) Mycelium spreading itself just below the cuticle and not entering the tissues of the host.

Disease affecting Cherry and Plum-trees.‡ — M. P. Vuillemin describes a fungus which has committed great ravages among the cherry and plum-trees in Lorraine.

In the first days of May the trees begin to droop, and at the end of the same month most of the leaves of the cherry-trees are covered with spots. Each spot is caused by a mycelium which is the product of a spore belonging to a conidial condition which has been named *Coryneum Beijerinki* Oud. The spore fixes itself on the under side of the young and slightly viscous leaves, and emits its tube which penetrates between two epidermal cells. The filaments enlarge and segmentation takes place, and in the centre of the spot one or more polyhedric cells are formed, which are very similar to the fructification formed in the genus *Entyloma*. These polyhedric cells finally assume the characteristic appearance of the conidia of *Coryneum*. Pycnidia are also developed towards the end of June; they are more abundant on the under surface of the leaf.

Oidium Fragariæ.§—Dr. C. O. Harz describes this new species, which is very destructive to cultivated strawberries, growing on the under side of the leaves, and causing abortion of the flowers or fruit. Conidia were the only reproductive organs seen. It closely resembles *O. Ruborum*, and may possibly be identical with it.

* Bergens Mus. Aarsberetning for 1886 (1887) pp. 219–26 (1 pl.).
† Ann. of Bot., i. (1887) pp. 163–76.
‡ Morot's Journ. Bot., i. (1887) pp. 315–20.
§ SB. Bot. Verein München, Jan. 17, 1887. See Bot. Centralbl., xxxii. (1887) p. 313.

Fungi of Finland.*—Herr E. Rostrup describes the following new species of parasitic fungi from Finland, viz.:—*Ustilago Warmingii* on *Rumex crispus*, *Tilletia arctica* on *Carex festiva*, *Æcidium Angelicæ* on *Angelica sylvestris*, *Trochila juncicola* on *Juncus compressus*, *T. Conioselini* on *Conioselinum Gmelini*, *Dothidella frigida* on *Phaca frigida*, *Sphærographium Vaccinii* on *Vaccinium uliginosum*, *Arthrinium naviculare* on *Carex vaginata*, *A. bicorne* on *Juncus compressus*, and *Ramularia salicina* on several species of *Salix*.

Protophyta.

Nucleus in Oscillaria and Tolypothrix.†—By the use of the following method Dr. D. H. Scott has been able to demonstrate the presence of a nucleus in the cells of several species of *Oscillaria* and *Tolypothrix*. The preparation was treated for five minutes with methylated ether, and then stained for four minutes with Kleinenberg's hæmatoxylin. The specimen was then mounted in Canada balsam. In the middle of each cell a deeply stained roundish body was seen, which had a distinctly fibrous structure, comparable to the "knot stage" of the ordinary nucleus as seen in pollen-mother-cells just before division. Other preparations were made by treating for two hours with picro-nigrosin solution, followed by immersion in saturated solution of chloral hydrate for two minutes, the filaments being subsequently mounted in pure glycerin.

Dr. Scott regards these observations as tending to obliterate the line of demarcation between Cyanophyceæ and true Algæ.

Microchæte.‡—Sig. A. Borzì has investigated the life-history of *Microchæte grisea*, which is always found attached to a *Calothrix*. Besides the ordinary mode of multiplication by hormogonia, he finds that this species produces *Chroococcus*-like reproductive bodies, gonidia or spores. From the germination of the hormogonia are produced directly flagelliform filaments endowed with a power of motion, which are indistinguishable from a *Calothrix*. The author concludes that *Microchæte grisea* must be regarded as merely a biological species, a phase in the development of *Calothrix parasitica*, or of some nearly allied species.

Life-history and Morphological Variations of Bacterium Laminariæ.§—M. A. Billet observed at Wimereux a new species of *Bacterium* in sea-water in which *Laminariæ* were macerated. It was found in four stages, which the author distinguishes as the filamentar, the dissociated, the interlaced, and the zoogloeic. The first is the initial state, and in it the organisms are colourless immobile filaments, the largest of which are about 120 μ long; the breadth is hardly ever more than 1 μ. The filaments are at first rectilinear, but as they grow they become more and more undulating, and finally they become arranged in from ten to fifteen spiral turns. The constitution of the filaments varies with the age of the culture; at first the protoplasm appears to be homogeneous and uninterrupted, but there are fine transverse striæ which have the appearance of septa; with age the protoplasm begins to segment, and as the joints appear the sheath of the filament becomes apparent. After a time the undivided filaments are replaced by chains of rectilinear elements which quit their sheath to enter the dissociated

* Bot. Tidsskr., xv. See Bot. Centralbl., xxxii. (1887) p. 257.
† Journ. Linn. Soc. Lond.—Bot, xxiv. (1887) pp. 188–92 (1 pl.).
‡ Malpighia, i. (1887) pp. 486–91. § Comptes Rendus, cvi. (1888) pp. 293–5.

stage. In this, at a given moment, elements of all sizes and forms are to be seen, some like *Leptothrix*, *Bacillus*, or *Bacterium*, others like *Vibrio*, and others like *Spirillum*; their principal character is their mobility, and they continue to segment very actively; when the segmentation comes to an end, there are a number of short *Bacterium*-like forms of great activity. The dissociated state is in direct relation with the activity of the phenomena of putrefaction. In the third stage the filaments interlace with one another, and extend over the surface of the culture-liquid; from this the zoogloeic stage is most often derived, though the latter may occur if a stop is put to the putrefactive activity. The zoogloeic patches are characterized by their distinctly stellate form, a mode of arrangement which has not hitherto been observed. The study of spore-formation is, unfortunately, incomplete, but in some filaments rounded corpuscles with a thick membrane have been observed. The author justly remarks that the facts which he has brought forward lend fresh support to the view that the bacterial elements vary in form.

Bacillus muralis.—Dr. A. Tomaschek* found in a forcing-pit at Brünn that various places on the walls were covered with slimy masses of the consistence of paste, and collected into warty prominences about 2 mm. high. Their colour was grey passing into violet, and in places a pure violet. In spirit they became rose-coloured, and afterwards gradually white. In water they fell in flakes to the bottom. Microscopical examination showed that the gelatinous masses were composed of rodlets resembling *Bacillus megatherium*. The individual rods were about four times as long as thick, their ends were rounded, and they were about 2·5 μ thick. They were rarely straight, being usually more or less curved, but only exceptionally as much bent as a horseshoe. Each was surrounded by a gelatinous transparent oval area; and by the use of finely powered indian ink it was shown that the gelatinous mass—zoogloea—is produced by the adhesion of the rodlets invested with a gelatinous envelope, and not by the confluence of the viscid primitive masses. Only where two rodlets were separating was there any community of capsule; not even in the fresh zoogloea were two rods ever seen in one capsule, still less could chain-formation be observed. After division the two rods separated from one another in such a way as to lie side by side, and the maternal envelope disappeared. The ends of the rods looked like bright spots, which might easily be mistaken for spores. The appearance of cocci lying between the rods was an optical illusion produced by the different positions of the bent rods. In the fresh gelatin taken directly from the glass-house, increase took place by means of successive fission. If the fresh mass were left in water for some days, and then poured into a flat vessel from which the water was gradually evaporated, endogenous spore-formation occurred. Staining with methylen-blue gave favourable results.

At the onset of spore-formation the rods consisted of 4–6 isodiametric cells, within which a strongly refracting body occurs, and out of it the spherical spore finally appears. Within the gelatinous capsule are simultaneously developed from the mother-cell a chain of 2-4-6-8 loosely associated individuals. Sometimes, however, the spores separate from the mother-cell, and after a period of rest, grow into rods. When transferred to the vicinity of a conduit pipe, where grew a tuft of *Oscillaria*, the bacteria grew more quickly, while all attempts at pro-

* Bot. Ztg., xlv. (1887) pp. 665–71.

pagation and cultivation in fluids had been without result. It is worthy of remark that within the gelatinous masses small colonies of *Glœocapsa* were invariably present. The constancy of their appearance indicates that this symbiosis is a mutualism or co-operation of functions of the two organisms such as exists in lichens between fungi and their attendant algæ. The settlement of the *Glœocapsa* is favoured by the softness and moisture of the zoogloœa, while in its turn it supplies the bacillus with oxygen, and receives in exchange carbonic acid.

With regard to the species of *Glœocapsa*, it may be remarked that at the edge of the zoogloœa, where it occurs without bacteria and forms blue-green rosettes, it corresponds to *G. polydermatica* Ktz.; in the zoogloœa layer, where the blue-green hue is fading, with *G. fenestralis;* and where it is quite decolorized, and the envelope become brown, it appears as *G. fusco-lutea.* Perchance other organisms may be included in the zoogloœa, e. g. protonemata of mosses. It is accordingly probable that bacteria occur with algæ in a symbiosis based on reciprocity of functions, and which promotes their mutual benefit.

Dr. A. Hansgirg * is convinced, from having examined the material presented to him by Tomaschek, that the *Bacillus muralis* is a form of *Aphanothece caldariorum* Richter, which Richter and Zopf declared to be a bacillus form of *Glaucothrix gracillima* Zopf. The *Glœocapsa* forms described by Tomaschek have been known for a long time to writers on Algæ, but under other names.

Bacteria in Hailstones.†—Dr. O. Bujwid relates how in May 1887, there fell at Warsaw during a storm, hailstones 6 cm. long and 3 cm. thick. He washed one of these thrice in sterilized water, and then, having broken it up into pieces 2–3 cm. in size, placed these in a test-tube, and then washed again three times with sterilized bouillon. After this there remained some water, with 1 cm. of which he inoculated two plates. In two days numerous colonies had grown in both plates, and had partially liquefied the gelatin. By means of Wolffhügel's apparatus 21,000 bacteria to the ccm. were counted. Certain of the colonies had a different appearance, and from twelve of these gelatin tubes were inoculated. In a few days there developed *Bacillus fluorescens-liquefaciens*, *B. fluorescens-putridus*, a mixture of rods and short Bacilli, which liquefy gelatin and form a dark violet scum on the surface. The latter form in a jar at the ordinary temperature whitish-grey colonies, which in two to three days assumed a blackish-violet hue.

Apparently this kind of Bacterium is none other than the *Bacillus janthinus* described by Zopf. The author had never found this in water from Warsaw and its neighbourhood. And as the foregoing bacteria are only found in foul water, he assumes that the water was taken up by the wind and deposited as hailstones at Warsaw!

Phosphorescent Bacillus.‡—Dr. B. Fischer, who has already described two phosphorescent micro-organisms in *Bacillus phosphorescens* and *Bacterium phosphorescens*, gives the following account of a third light-developing Bacillus which he has found to inhabit the water of the Baltic Sea:—

The number of germs to the cubic centimetre of water varies from 4 to 20. It was also obtained from raw herrings, to which, along with

* Bot. Centralbl., xxxiii. (1888) pp. 87–8.
† Centralbl. f. Bakteriol. u. Parasitenk., iii. (1888) pp. 1–2.
‡ Ibid., pp. 105–8, 137–41.

Bacterium phosphorescens, it imparts the phosphorescence. This "endemic light-bacillus," as it is named, has many points in common with *Bacillus phosphorescens*, which is found in the West Indies. It consists of short thick rods with rounded ends, and is endowed with lively movements. In length they vary between 1·3–2·1 μ, and in breadth between 0·4–0·7 μ. They are usually seen lying in pairs, just having or just about to divide. They stain with the ordinary anilin dyes. The rodlets grow in ordinary gelatin, but better when 30 per cent. of salt or fish gelatin is added. In plate-cultivations the surface of the gelatin is eaten out into circular pits by the colonies, which, when young, are of a pale sea-green colour, but as they increase in size assume a dirty greyish-yellow hue. Tube-cultivations give a characteristic appearance resembling a funnel at the inoculation-place, and this at the end of the first week is about 2 mm. wide and about 1 cm. deep. This bacillus not only grows at ordinary temperatures, but also thrives at 5°–10° C., and in this respect differs from the West Indian variety, which does not develope below 15° C. The addition of salt to the gelatin accelerates the growth, and while deprivation of air delays development, it does not altogether prevent it.

The light emitted from the cultivations of this bacillus is bluish-white, not green like that of *Bacterium phosphorescens*. The light from the cultivations is strongest from fresh ones and diminishes with age, although after two months light is still visible in some tube-cultures. At temperatures between 5–25° C. no marked difference was visible, while higher degrees diminished the strength of the light. The addition of salt to the gelatin was found to increase the intensity of the light. Spectroscopic examination gave a continuous spectrum from D to somewhat beyond G, the maximum of brightness lying between E and the middle of F and G. Colour differences were unrecognizable. Attempts to photograph the colonies did not give very satisfactory results.

Spirillum concentricum, a new species from decomposing blood * —Dr. S. Kitasato premises that his *Spirillum* does not betray any pathogenic characteristics. It was obtained from bullock's blood and cultivated on gelatin at a temperature of 20–22° C. On gelatin plates the colonies appear as pale-grey discs formed of concentric rings, whence their name. The spirilla grow on gelatin without liquefying it. In test-tube cultivations they grow better on the surface than beneath. On agar it would appear that the *Spirilla* grow not only along the inoculation-track, but invade the adjacent parts, and the cultivation adheres so closely to the surface that if an attempt be made to remove any, the subjacent agar is torn away with it. On the whole, the growth of the *Spirillum* was found to be more luxuriant at ordinary temperature than in the incubator; the most suitable being between 20° and 23° C.

Microscopically, the *Spirilla* are short screws with two to three turns and pointed ends. Cultivated in bouillon they grow to long screws with five to twenty turns. The diameter is 2·0–2·5 μ, and the length of a turn 3·5–4 μ. The thickness of the *Spirilla* is somewhat greater than that of the cholera bacilli. In hanging drops upon hollow-ground slides they exhibit lively wriggling movements like the *Spirillum rubrum*. They stain well with the ordinary anilin dyes. No evidence of resting forms was found. Mice, guinea-pigs, and rabbits were not affected by injections of the pure cultivations.

* Centralbl. f. Bakteriol. u. Parasitenk, iii. (1888) pp. 73–5.

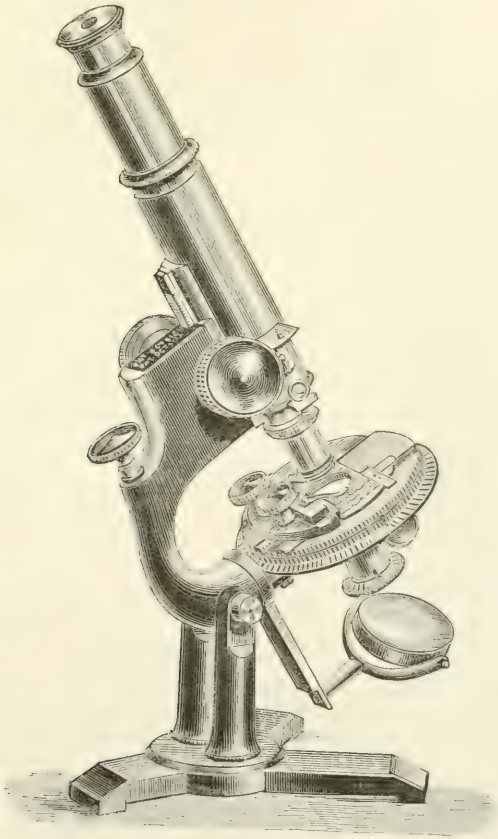
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Bausch and Lomb Optical Co.'s Petrographical Microscope.—This instrument, fig. 40, was founded on suggestions of Dr. G. H. Williams, Associate Professor of Mineralogy and Inorganic Geology in the Johns-

Fig. 40.



Hopkins University.† The general form of the stand is the Bausch and Lomb Optical Co's "Model" Microscope,‡ with their watchspring fine-adjustment, and the mechanical stage described in this Journal, 1887,

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

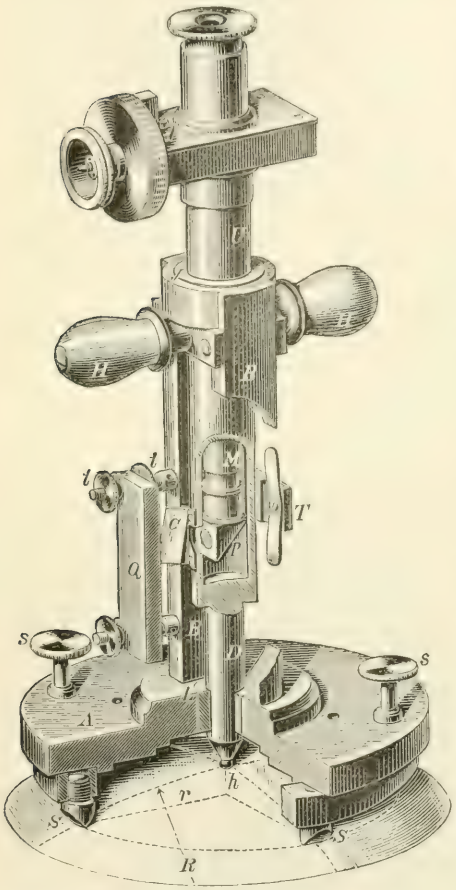
† Cf. Amer. Journ. Sci., xxxv. (1888) pp. 114–7 (1 fig.).

‡ It can also be applied to the "Universal" and "Professional" forms.

p. 651, with graduated scales for the rectangular movements and graduated circle and index.

The nose-piece is provided with a special adapter to which the objective may be screwed, and into which slide the four following accessories, each mounted in a separate brass frame: (*a*) Bertrand lens; (*b*) quarter undulation plate; (*c*) quartz wedge; (*d*) Klein's quartz plate. The nose-piece has also centering screws. The analyser is inclosed in one side of a double-chambered box, the other side being left vacant, so that it may be slid in or out of the tube at will without at any time leaving an opening through which dust may enter.

Fig. 41.



Bamberg's Spherometer Microscope.*—Dr. S. Czapski describes this intrument (fig. 41) as follows:—B B is a strong brass frame fixed in a circular disc A, to which spherometer rings of different diameters can be fastened by the screws *s s*. Complete centering of the rings is secured by circular projections of rectangular section turned upon the under surface of A. The spherometer ring is either entire or consists (as in the figure) of four hard steel segments S S, which form parts of a complete circle turned upon the lathe. J and L are steel guides for the strictly cylindrical steel tube U, which contains the micrometer Microscope M. U terminates below in a steel cylinder D, at the end of which is a small sphere. P is the reflection prism placed under the objective, and in front of it is an aperture in U through which a scale Q, divided to 0·2 mm., and illuminated by the mirror C, is viewed in the Microscope. The scale Q is attached to the frame B by four screws, and adjusted by the nuts *t t* to the focus of the Microscope. Any vertical movement of the Microscope in its bearings can be measured by the divisions of the scale, which are then seen to travel across its field. The drum gives thousandths of a millimetre direct, and tenths of these can be estimated with safety. Behind U

* Zeitschr. f. Instrumentenk,, vii. (1887) pp. 297–301 (3 figs.).

is a crosspiece T, which at one end presses directly against the frame B, acting at the other by means of a weak spring. This is designed to keep the tube firm in its bearings, to prevent any rotation, and to make it impossible for the tube to leave the frame altogether. The instrument is carried by the wooden handles H H.

In using the instrument it is placed gently on the spherical surface to be determined, which, if a thin lens, is supported on a ring of the same diameter as the spherometer ring. The Microscope is focused, and a reading is taken on the scale by the micrometer. The zero-point having been found by placing the spherometer on a true plane surface, and the difference of readings being = h, then R the radius of the sphere = $\frac{h^2 + r^2}{2h}$ where r is the radius of the ring.

A better method of determining h is to dispense with the plane surface, and to take half the difference between the readings for the spherical surface, and for another spherical surface of exactly equal and opposite curvature. In this way it is possible to eliminate the error due to the fact that a ring which has not a perfectly fine edge rests upon a concave surface with a greater diameter, and upon a convex surface with a less diameter than the measured diameter of the ring.

If such an equal and opposite surface cannot be obtained, the curvature of another lens of nearly the same radius which has an equal and opposite surface is first determined in the above way; this is compared with the curvature as determined by the aid of a plane surface, and so the error for a lens of nearly the given curvature is ascertained. The given lens is then measured by means of a plane surface, and the known correction applied in estimating the value of h.

Galland-Mason's Microphotoscope.—If it is true that the world sometimes knows nothing of its greatest men, it would appear to be also true that the world sometimes may be ignorant of its greatest inventions. At any rate, although we are always on the look-out for all that is novel, and much that is curious in microscopical matters, we have only now become acquainted with Mr. R. Galland-Mason's patent for the "Microphotoscope." The instrument which the patentee gives this name consists of a pair of spectacles with a number of microphotographs arranged along the upper part of the rims, and placed in front of minute magnifying glasses by which they are made visible to the wearer of the spectacles. The rims being detachable, the microphotographs (of written or printed matter, maps, or other objects) can be changed as desired. As the patentee says, "a lecturer might have his lectures photographed and placed in the rim of his spectacles, an actor his plays, a lawyer his briefs, a clergyman his sermon, a tourist, maps, views, and plans of the country through which he travelled, a shopkeeper a ready reckoner, calendar, &c., a timber merchant cubes, measurements and rules, and so forth."

In the first patent, which was taken out in 1884,* the patentee had provided a separate lens for each microphotograph. This he subsequently found to be superfluous, and in the following year he obtained a second patent † for the "Improved Microphotoscope" in which only one lens is used. There are occasions, and this is one of them, when (like the

* 1884, 8th January, No. 912. † 1885, 24th January, No. 1027.

stigma of treachery applied to translators) to abstract would be to betray, and we therefore give the specification in full.

"The improved microphotoscope consists in arranging microphotographs in spectacles, eye-glasses, or hand-glasses, in concentric circular groups, so that each microphotograph may be brought separately under or before a single minute Microscope instead of each microphotograph being provided with a separate lens.

The Microscope may be placed in a radial slide. This radial slide is to enable the Microscope to be moved opposite to any circle of microphotographs; or it may be let into the rim of the spectacle glass, and provided with a minute screw for focussing for varying sights.

The microphotographs would be taken upon a piece of circular glass, gelatine, or any suitable transparent substance; in photographing them it would not be necessary to take each microphotograph separately.

If the models from which the microphotographs are taken were arranged in a circle, the whole circular group of microphotographs could be taken on one negative.

The gelatine film or other material upon which the microphotographs are taken (and also the microphotographs themselves) may be protected from injury by friction, &c., by being placed between two very thin pieces of glass, talc, or any other suitable transparent substance, and the whole cemented together with transparent cement so as to form one piece.

These circular pieces of glass or other material upon which the microphotographs are taken, may be made to fit into loose frames in such a manner that they may be taken out at will, and others put in their places. These frames have several small catches or claws, by which they may be made to spring or clip on to spectacles, eye-glasses, or hand-glasses of a circular form.

The edges of these loose frames may be milled, which when taken between the thumb and finger, enables them (the loose frames) with the glasses they contain to be turned round and adjusted with the utmost nicety; or the spectacles, eye-glasses, or hand-glasses, may have catches on their rims into which the circular glasses containing the microphotographs may themselves be sprung, or taken out at will; thus dispensing with the loose frames. In this case the glasses containing the microphotographs would be a little larger than the spectacle glasses, to enable the thumb and finger to take hold of them when turning them round.

This is the movement which brings each of the circularly grouped microphotographs under or before the small Microscope which is fixed in the rim of the spectacle glasses—on the side next the eye—in such a manner that it may either be used radially or focussed for varying sights by means of a minute screw.

This circular movement is preferably obtained by the above method, but may also be obtained by revolving with the thumb and finger a minute rubber or other roller attached to the spectacles, eye-glasses, or hand-glasses, and pressing upon the glass or other substance containing the microphotographs, or upon the loose frame in which the glass or other substance is fixed; or this movement may be obtained by a worm fixed on the spectacles, eye-glasses, or hand-glasses, and working into teeth in the loose frame; or again the movement may be given by depressing a minute spring-stud on the rim of the spectacles, eye-glasses,

or hand-glasses, which acting upon teeth in the rim of the loose frame, turns it round a tooth at the time.

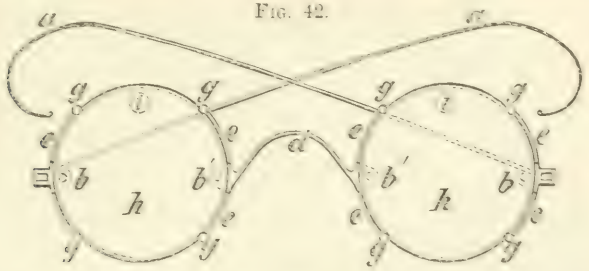
In the case of hand-glasses the radial slide which holds the Microscope, may be attached to the centre of the glass, or other material around which the microphotographs are grouped.

The spectacle glasses may be sighted for those who require them sighted, and plain clear glass for those who do not.

In order that the practical application of my invention may be clearly understood, I have annexed hereto a sheet of drawings in which (for the sake of illustration) my invention is shown as applied to a pair of spectacles of the kind ordinarily designated 'frameless.'

Fig. 42 illustrates the appearance of the improved microphotoscope when worn, differing very slightly in appearance from an ordinary pair of 'frameless' spectacles. Fig. 43 is an end view of the same enlarged.

FIG. 42.



a, *a* are the ear-pieces, *b*, *b* the plates to which the ear-pieces *a*, *a* are hinged, *c*, *c* are the spectacle glasses * to which the plates b^1, b^1 attached to the nose-piece *d* are also screwed.

The arms *e*, *e* spring from the plates *b* and b^1 (see also fig. 44 which is a front view of the metal parts detached from the glasses) and follow the curve of the spectacle glasses *f*, *f*. These arms *e* are bent at their ends, and provided with small round knobs *g*, *g* which act as spring clips, holding the glasses *h*, *h* which contain the microphotographs securely, and at the same time allowing them to be sprung out and replaced by others with the greatest ease: *i*, *i* is the minute Microscope before which any one of the circularly grouped microphotographs on the glass *h*, *h* may be brought by moving the latter round between the thumb and finger.

For this purpose the glass *h*, *h* is made slightly larger than the spectacle glass *f*, *f*.

The microphotographs may be copies of books, pamphlets, newspapers, or any written or printed matter, maps, charts, views, landscapes, pictures, or any object or group of objects from which photographs can be taken.

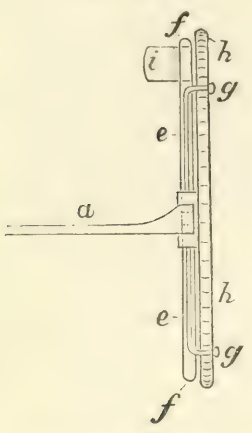
The uses to which the improved microphotoscope could be put would be similar to those described in my specification of the microphotoscope above referred to, but in a more enlarged or extended sense, as a pair of glasses *h*, *h* which slip into the spectacle frames would be capable of holding from two to three hundred microphotographs.

If these were copies of the leaves of a book, then in one pair of

* There is no *c* in the drawings.

spectacles or eye-glasses, a person would be able to carry the contents of a whole volume, and as the glasses are detachable and very thin, a person would be able to carry from fifty to a hundred pairs of these in a case less than an ordinary pocket-book.

Fig. 43.



The glasses might be numbered, and the case contain an index of the subjects; thus a person would be enabled to carry from fifty to a hundred volumes in his waistcoat pocket.

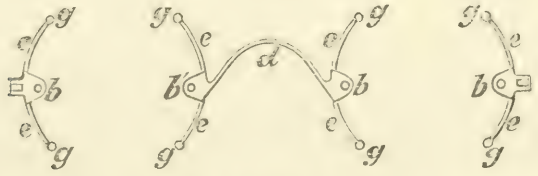
By the aid of the type-writer in preparing the text, books instead of being printed could be published microphotoscopically with greater expedition than at present, for the known resources of the modern photographer are so great that within twenty-four hours of receiving the text, he would be able to place numbers of microphotoscopical copies in the market.

Microphotoscopical books would be almost indestructible, would never become mouldy or worm-eaten, and would take up so little space that a very large library could be contained in a small cabinet.

The postage and carriage of books so published would be very small, and would be a great gain to those who had to send them abroad.

The captain of an ocean-going vessel could have copies of his charts, maps, &c., in his spectacles, and in times of danger and peril would not require to leave the bridge for the chart room. In the darkest and stormiest night, by looking towards any of the lights that a vessel

Fig. 44.



generally carries, or by looking towards the moon or even the stars, he could see his charts and maps as distinctly as in the daylight; for the matter contained in the microphotoscope can be read in a light so dim that ordinary printed matter cannot be seen.

The University student would be able to carry all his text-books in his waistcoat pocket, however diversified his studies were; the doctor, lawyer, or literary man would be able to have always with him microphotoscopical copies of all the works of reference he could possibly require. A man with a bad memory might have microphotoscopical copies of a whole encyclopædia always before his eyes. In a single pair of glasses the leader of an orchestra could carry more music than he would be able to get through in one evening; a continental traveller, a whole pronouncing dictionary; a cyclist or tourist, maps of every road in the United Kingdom or other country; a member of parliament or

other public speaker, the whole of his speech*; a lecturer, the whole of his lecture; and a detective the features of three hundred criminals, and so on, to an almost indefinite extent.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:

The combination in the instrument called the 'microphotoscope' of a single fixed or adjustable lens or Microscope with movable or detachable circular glasses or other media containing one or more circular or concentric groups of microphotographs, so arranged that each or any microphotograph may be brought separately under or before the said fixed or adjustable lens or Microscope (instead of each microphotograph being provided with a separate lens) substantially as hereinbefore particularly described and illustrated by the drawings annexed."

Bastin-Bullock Microscope.

["Designed by Prof. Bastin especially for the needs of pharmacognosists."]

Amer. Mon. Micr. Journ. IX. (1888) p. 35, from *Western Druggist.*

Electric Microscope.

["We learn that Prof. Waldeyer of Berlin is having an electric Microscope constructed in Vienna for electric light demonstrations. We presume this instrument is to take the place once occupied by the Solar Microscope."]

Scientif. News, I. (1888) p. 52.

MINOT, C. S.—**American Microscopes—A Complaint.**

[A very sweeping condemnation of American Microscopes, and a recommendation to Americans to purchase only European ones.]

Science, 1887, December 2nd.

[Comments on same in *Microscope*, VIII. (1888) pp. 20–2; *Amer. Mon. Micr. Journ.*, IX. (1888) p. 15; *Bot. Gazette*, XIII. (1888) pp. 38–9; *Queen's Micr. Bull.*, IV. (1887) pp. 41–3.]

(2) Eye-pieces and Objectives.

Apochromatic Objectives.†—We give Mr. E. Gundlach's paper on this subject *in extenso*, for, like his previous papers, any attempt at abstract would conflict with the proper appreciation of his views.

"The almost generally prevailing opinion, that the Microscope objective has been brought so near to perfection as to leave little or nothing for its further improvement, has been greatly modified by the appearance of new and superior material of which to construct optical lenses—the apochromatic glass of Schott & Co., of Jena, Germany. The fact that this new glass has solved the long-pending problem of removing or reducing the secondary spectrum, has naturally aroused the most sanguine hopes for a general improvement of the Microscope objective. These hopes would doubtless long ago have been realized, through the efforts of the able opticians of the world, if the new glass did not have, aside from the great virtue of reducing the secondary spectrum to a minimum, some serious drawbacks not connected with other optical glass. In fact, if the new glass were, or could be made, in every respect similar to the ordinary optical glass, the objectives could be made of it in exactly the same manner and after the same formulæ as they are now, and their optical qualities would be just the same in every

* In the specification to the patent of 1884 the member of parliament was only to have the "facts and figures relating to the subject of his speech."

† Read before the American Society of Microscopists, Pittsburg, August 30th, 1887. The Microscope, viii. (1888) pp. 6–8.

respect, but with the secondary spectrum considerably reduced, and, consequently, the definition greatly improved. But, unfortunately, this is not the case. In my paper at last year's meeting, I pointed out the fact, derived from figures of the refractive and dispersive powers of the new glass, as furnished by the makers, that the proportions of powers were such as to require extremely short curvatures, which would produce a very injurious amount of aberrations of the second order, and that this error would probably overbalance the advantages of the reduced secondary spectrum. Since that time, however, I have tried the glass, and found my assertion to be correct. Indeed, it could not well be otherwise, as figures seldom lie. In fact, it would be impossible to construct from the new glass Microscope objectives of superior quality after the usual or known plans. Our present low powers, for instance, from 1/2 in. down to 3 or 4 in., are now almost universally constructed after the dialytic principle, being two widely-separated systems, each consisting of a crown and flint glass of moderate optical powers and forming an achromatic lens, or nearly so, for itself. This objective has almost perfect optical symmetry, and forms, therefore, a very even and flat field of fine definition and brilliancy. No addition of lenses, nor any change of form could improve this objective, but would rather impair its quality. But the new apochromatic glass is entirely unfit for this form of objective, for the reasons heretofore given. I was led, therefore, to consider whether another form of construction could be found to which the new glass could be advantageously adapted, and I have succeeded in solving the problem so completely that, for theoretical reasons, I do not hesitate to claim my new formula to be the only proper one for the new glass. My new apochromatic objectives contain at least one triple lens of my new construction, adapted to the new glass. The 1/8 in. is a homogeneous-immersion objective of 1·42 N.A., and 1/50 in. working distance. It contains two triple systems and two single lenses, of which the back system is constructed after my new invention. Of this objective seven lenses are made of the new apochromatic, and the eighth of another new glass. The 1/4 in. is a dry working objective of 100° aperture. It is a three-system, and all but one of its lenses are made of the apochromatic glass, the back system being a triplet of my new form. The low powers are constructed after the dialytic, and consist of two triplets, both of my new form. Thus these objectives are made entirely of the new apochromatic glass. These new dialytic objectives, aside from being practically entirely free from any disturbing colour, and in every other respect fully equal to the ordinary dialytic of the best quality, are far superior to any objective in flatness of field, and are therefore, unlike the European apochromatic objectives, in less need of 'compensating eye-pieces' than the best ordinary objectives.

As a very important advantage of the new apochromatic objective over the ordinary one, I regard the absence of a separate chemical focus, which quality makes the objective especially adapted to photographic work. A 1 in. has recently been tested photographically, with a distance of 1½ feet between the objective and the image, and not a trace of the usual difference between the visual and active foci could be found, and the resulting picture was of unusual sharpness and brilliancy."

Dr. F. L. James says* that "one immense advantage which these

* St. Louis Med. and Surg. Journ., liii. (1887) pp. 356–7.

objectives possess over those of Zeiss and other makers is that they do not require a specially constructed and corrected eye-piece, but give equally good results with any well-constructed Huyghenian ocular."

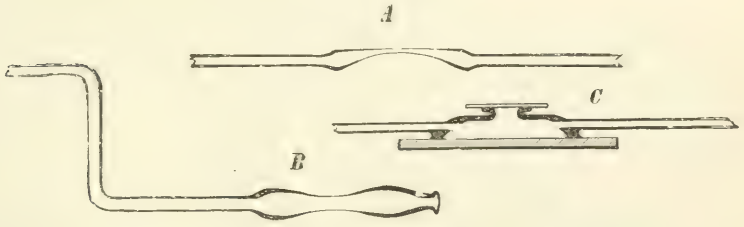
Cheap Objectives.*—Is there not a little something wanting in the following recommendation of an objective which we quote from a learned contemporary? "The oil-immersion objective is remarkable for its "powers of definition; it has been tested against many of Leitz's, which "hitherto have been the cheapest obtainable, and has been found superior "to them. *This is high praise*, as the price of the two is the same."

GIFFORD, J. W.—**Apochromatic Objectives.**
Journ. of Microscopy, I. (1888) pp. 9–11.

(3) Illuminating and other Apparatus.

Geissler's Culture Tubes.†—Dr. O. Brefeld's researches on *Bacillus subtilis* were undertaken with the apparatus of G. F. Geissler, shown in fig. 45.

FIG 45.



A glass tube of nearly capillary diameter widens in the centre in the form shown at A, the upper and lower sides approaching each other so closely, that there is only a very small space between them. A drop of liquid drawn through the tube remains, by capillary attraction, in the centre without drying up, and can thus be easily subjected to examination by the strongest objective.

Other forms have dissimilar-tubes, as shown at B or C; the centre in the latter is open beneath and fastened upon a glass plate, whilst another smaller aperture above is intended to take the glass cover with the object in a hanging drop.

Gas and Moist Chambers.—It is often necessary to ascertain the influence of various gases upon the objects under examination, and for this purpose various devices have been made use of, known as "gas chambers."‡ The different forms of "culture cells" are readily convertible into gas chambers, and a great variety of suggestions have been

* Brit. Med. Journ., 1887, No. 1391, p. 470.

† Bericht ü. d. Wiss. Instrumente a. d. Berliner Gewerbeausstellung im Jahre 1879 (Löwenherz), 1880, pp. 304–5 (1 fig.).

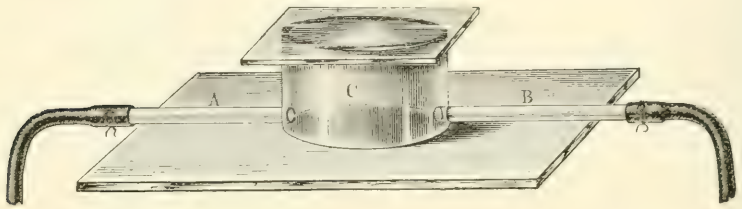
‡ C. Robin describes Poiseuille's "Porte-objet pneumatique" of 1832, as the first known "gas chamber." This was, however, a copper box (with two apertures closed with glass) in connection with an air-pump to experiment upon the effects on living organisms of condensing or rarefying the air. Cf. 'Traité du Microscope,' 1877, p. 159.

made, including those of *Stricker*,* who converted his putty cell so as to make it available for gas, by the simple process of introducing two small glass tubes through the putty, and a second form, with a mercurial valve, which he † adapted from Kühne. *Harless* used two glass slides, the sides of which were cemented together so as to keep them about 0·5–1 mm. apart; the two ends were fixed in pieces of cork, and two tubes passed through the corks communicating with the space between the slides. *Kühne's* was a small glass box into which two tubes were led. *Huizinga* ‡ used a glass tube with a bulb in the centre, ground off above and below so as to have two openings, both of which were closed by cover-glasses, the object being placed on the under side of the upper one. *Heidenhain's* § was a square metal box with apertures closed by glass plates. *T. W. Engelmann's* ‖ was also similar.

The following forms have not yet been described in English:—

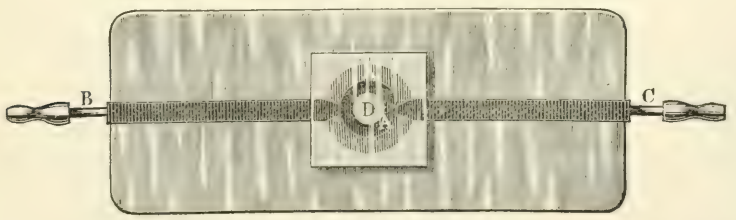
Böttcher ¶ suggests the apparatus shown in fig. 46, consisting of a short piece of tube C, and two tubes A and B, all cemented to a slide.

Fig. 46.



In *Strecker's* ** (fig. 47) a hollow space with a groove A is cut away from a thick glass plate, and is surrounded by a glass ring of pro-

Fig. 47.

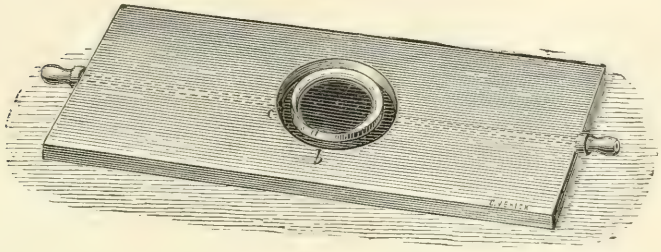


portionate height cemented to the plate. At two opposite points of the latter, and along the diameter of the plate, are shallow grooves in which are cemented the glass or metal tubes B and C extending as far as the groove A; one of these is connected with the gas reservoir by means of a guttapercha tube. The object is suspended in the central space D.

* 'Manual of Human and Comparative Histology,' transl. by Power, 1870, pp. viii.–ix. (1 fig.).
† Op. cit., pp. xi.–xii. (1 fig.).
‡ Med. Centralbl., 1867, p. 675.
§ Thanhoffer's Das Mikroskop, 1880, pp. 86–7.
‖ Jenaisch. Zeitschr. f. Med. u. Naturwiss., iv. (1868) pp. 331–3.
¶ Dippel's Das Mikroskop, 1882, p. 663 (1 fig.).
** Ibid., pp. 663–4 (1 fig.).

Prof. Ranvier * recommended the apparatus shown in fig. 48. A brass plate *b* has a circular aperture of 2 cm. closed with a plate of glass,

Fig. 48.



to which is fixed a smaller glass disc *a*, so as to leave a circular groove *c*. When the cover-glass is put on there is 0·1 mm. between it and the upper surface of the disc. Two holes pierced through the brass plate longitudinally admit and draw off the gas.

M. A. Nachet improved on this by the gas chamber shown in figs. 49 and 50, which has the advantage that the glass on which the liquids to

Fig. 49.

Fig. 50.

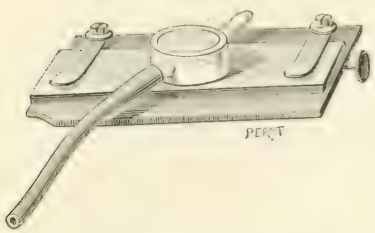
be examined are placed can be raised or lowered by a fine micrometric screw let into the thickness of the metal plate. By this means the thickness of the layer of liquid beneath the cover-glass can be increased or diminished.

The modified cells of *Nachet* (for allowing culture systems to be multiplied indefinitely) which we described at p. 708 of Vol. III. (1880) are shown in fig. 51. These were specially intended for use with the Chemical Microscope, where the objective is beneath the slide. A brass plate is attached to the stage and holds, by clips, the glass slip to which the gas chamber is attached. This consists of a glass ring and two tubes in one piece. The bottom of the ring is closed by a piece of cover-glass, and is cemented over an aperture in the slide. The body-tube and objective of the Chemical Microscope, it will be remembered,

* 'Traité technique d'Histologie,' 1875, pp. 44-5 (1 fig.).

moves over the stage, so that the complete immobility of the object is assured. "If one reflects on the necessity of attaching indiarubber tubes to two glass tubulures, and to be certain of the perfect immobility of certain anatomical elements, the advantage of such an arrangement will be readily understood. Experiments in the culture of ferments, the absorption of gases, the rarefaction and compression of air are thus greatly facilitated." *

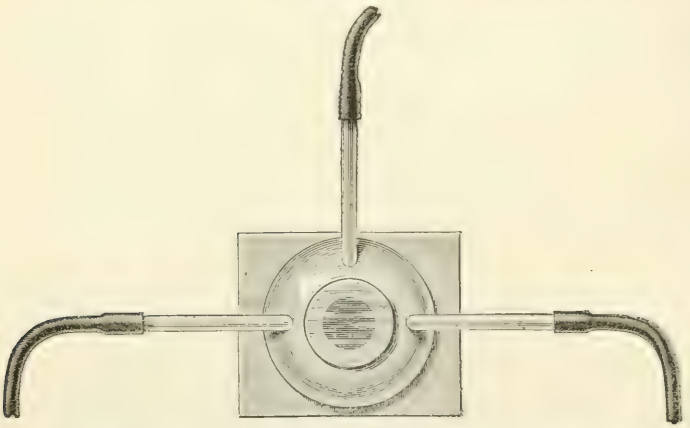
Fig. 51.



The most complete form of apparatus, however, for experimenting with gases is the *Stricker-Sanderson* hot stage, which is described and figured in this Journal, 1887, p. 309, fig. 68.

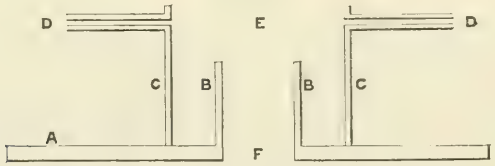
To allow of a rapid change of gases, *Lancaster's* apparatus † (fig. 52), made out of a watch-glass, had two glass tubes for the entrance of the

Fig. 52.



gases. These were connected with indiarubber tubes provided with spring clips, so that different gases could be experimented with in rapid succession.

Fig. 53.

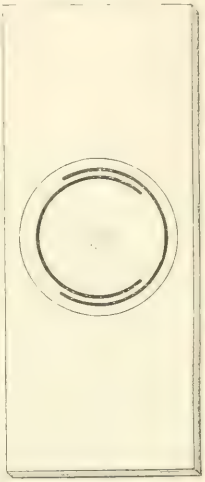


Hansen's Moist Chamber ‡ is shown in fig. 53, where A is a glass plate with a central aperture F, and having two rings C and B. The

* Catalogue, 1886, pp. 33–5 (2 figs.). † Dippel, op. cit., p. 664 (1 fig.).
‡ Meddelelser fra Carlsberg Laboratoriet, 1881, pp. 184–6 (2 figs.), with French résumé.

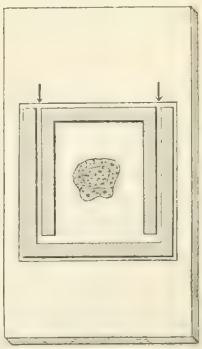
object is placed on a cover-glass, which is cemented with vaseline to the lower side of A, closing the opening. The space between the two rings is filled with water. Two tubes at D admit air or gas to the interior, and the top of the outer ring is closed at E by a cover-glass cemented on. It is claimed that it combines the advantages of the moist chambers of Böttcher and Ranvier. The nutrient fluid has a free surface, as in Böttcher's, but faces upwards instead of downwards, an advantage in many cases; and, as in Ranvier's, is steady. It resembles Ranvier's in having the water, which assists in preventing the evaporation of the nutrient fluid, separated from it. The construction allows, moreover, of a new fluid being introduced, and parts of the old one removed, without, at least in certain conditions, disturbing the vegetation. It is possible, therefore, to commence the culture with a single cell, and proceed gradually to a large mass. The chamber can be used only with Microscopes where the objective is below, and the illuminating mirror above the object which is being examined.

Fig. 54.



Dr. T. R. Lewis's Moist Slide * is shown in fig. 54. Two semicircles of asphalt varnish were brushed on the slide, one being rather larger than the other, so that the ends of one half-circle might overlap the other, but not so closely as not to permit the entrance and exit of air. When nearly dry a minute quantity of growing fluid was placed in the centre, upon which a few spores were sown, a cover-glass being placed over it, which adhered to the semi-dried varnish. The slide was placed under a bell-glass, kept damp by being lined with moist blotting-paper.

Fig. 55.



Dr. Maddox's Slide is shown in fig. 55. A strip of tinfoil is cut into two ∪-shaped pieces, one being larger than the other, so that when the smaller is placed upside down ∩ it will fit loosely inside the upright portion of the other. These are fixed in this position on a glass slide with a little varnish, over which a thin cover-glass is so arranged that the only air or foreign matter which can reach the preparation must pass up the "chimney" thus formed, between the inner margin of the larger strip of the tinfoil, and the outer one of the smaller. The arrows indicate the spaces left open for the admission of air.

Bertrand's Refractometer.†—Mr. E. Mallard finds that this instrument ‡ requires certain corrections due to the fact that the lower surface of the hemispherical lens does not pass exactly through the axis of rotation.

* 'Report on the Microscopic Objects found in Cholera Evacuations, &c.,' 1870, p. 17 (1 fig.).

† Bull. Soc. Franç. Mineral., ix. (1886) pp. 167–71. Cf. Neues Jahrb. f. Mineral., i. (1888) Ref. p. 10.

‡ See this Journal, 1887, p. 469.

If the instrument is in perfect adjustment, the readings are expressed by the formula $n = N \sin \phi$, where n is the index required, N is the refractive index of the hemispherical lens, ϕ is the angle between the position of the lens for total reflection, and that in which its base is perpendicular to the axis. The apparatus must be graduated by experiment, and the value of N is found by observing some substance whose index is known. If N′ and ϕ' are the observed values, and νf their errors, the above equation becomes $n = (N' + \nu) \sin (\phi' + f)$, or expanding and neglecting terms of the second order $\frac{n}{\cos \phi'} - N' \tan \phi' = \nu \tan \phi' + f N'$. From this formula N and f are determined by observation of a number of known substances.

In the refractometer examined by M. Mallard $f = 1° 44'$, but when the correction was applied, indices of refraction were given correctly to two or three units in the fourth place of decimals.

Apparatus for Microphysical Investigations.* — The following notes are by Dr. O. Lehmann:—

Warming and preserving the objects.—Fine wire gauze should be used with the author's crystallization Microscope to prevent the cracking of the slide during the heating of the object. To preserve the object the author runs a drop of paraffin round the edge of the watch-glass which covers it, by which it is then hermetically inclosed. For sudden cooling it is advisable to use mercury, in which the slide is immersed with the cover-glass downwards.

Change of solubility by pressure.—A Cailletet pump, filled with glycerin, is connected by means of a long copper capillary tube with a glass capillary, which is cemented on the stage of the Microscope with shellac. The glass tube is previously filled with a hot saturated solution and the end of the tube is then sealed. The capillary is placed in a drop of oil on the stage, and covered with a flat watch-glass. After waiting until the conditions are constant, the pressure is suddenly raised to 300 atmospheres, and so maintained; any crystal in the capillary is then seen to be slowly increasing in size; after a few minutes this growth ceases, and if the pressure is then withdrawn re-solution will commence, the edges and corners becoming rounded, and the faces corroded.

Microscopic determination of capillary pressure.—A fine capillary tube of a diameter less than 0·001 mm. is connected with an apparatus for regulating the pressure. The apparatus consists of two receivers, one filled with compressed and the other with rarefied air, both connected with the capillary by means of cocks. The pressure is measured by a large mercurial manometer. The end of the capillary tube having been brought into a drop of water upon a slide, and covered with a cover-glass, the pressure is regulated so that the water which has entered the tube is just driven back to the aperture. The author has used pressures of nearly five atmospheres.

It may be also proved by this apparatus that the capillary attraction and viscosity diminish as the temperature increases. The diameters of very fine tubes are determined by immersing them in a liquid having the same index as the glass of which they are made, and measuring with an eye-piece micrometer.

* Zeitschr. f. Kryst., xii. (1887) pp. 377–410. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 115–23.

Microscopic determination of vapour tensions.—The method consists in introducing the vapour into a U-tube, one leg of which is closed, while the other is connected with two receivers containing compressed and rarefied air respectively; for microscopic measurement the U-tube is a capillary, its horizontal part is immersed in a water or paraffin bath, and examined by a Microscope with horizontal tube bent at a right angle near the objective. The use of capillary tubes has the advantage that minute quantities of the substance are employed and can be examined under very high pressures. The observation should be made when the vapour volume is as large as possible in comparison with the expansion of the liquid in contact with it.

Microscopic determination of the thermal expansion of liquids.—For this purpose a similar apparatus is used except that the U-tube is replaced by another, one leg of which terminates in a funnel and ground-glass stopper, while the other has a horizontal capillary tube projecting from it to contain the experimental liquid. This tube can be maintained at a constant temperature by a water or oil bath, and is observed by the horizontal Microscope; it is filled by heating to expel the air and then forcing the liquid in by pressure from one receiver; the superfluous liquid is then removed and the remainder of the tube filled through the funnel by suction from the other receiver with some coloured fluid. Coloured glycerin, for example, may be used in examining the expansion of carbon disulphide, the movements of the point of junction between the two liquids being followed by the horizontal Microscope.

Microscopic determination of compressibility.—For this the author uses the Cailletet apparatus; the liquid is contained in a vessel like a thermometer, the end of which is inserted into the glass capillary used for liquefying gases.

KLAATSCH, H.—**Ein neues Hilfsmittel für mikroskopische Arbeiten.** [Radial micrometer.] *Anat. Anzeig.*, 1887, pp. 632–4.

(4) Photomicrography.

Photomicrography of Chemical Preparations.*—Dr. O. Lehmann recommends the use of oblique illumination and the colouring of the preparations; in photographing crystals it is important that they should appear upon a dark ground, and this is best effected by the Töpler contrivance as constructed by Seibert, in which half the field is darkened by a screen below the stage, and the other half by a screen above the eye-piece. As crystals cannot be coloured like organic preparations, it is best to use polarized light with doubly refracting crystals at any rate. By using the nicols parallel, or not crossed, the crystals are made to appear bright, dark, or coloured upon a bright or dark field.

Neuhaus's Photomicrographic Camera.—Dr. R. Neuhaus's camera is claimed to be distinguished from others which serve the same purpose by the fact that it can be extended to the length of 180 cm., and that the focusing of the Microscope can be simply effected for any length of the camera.

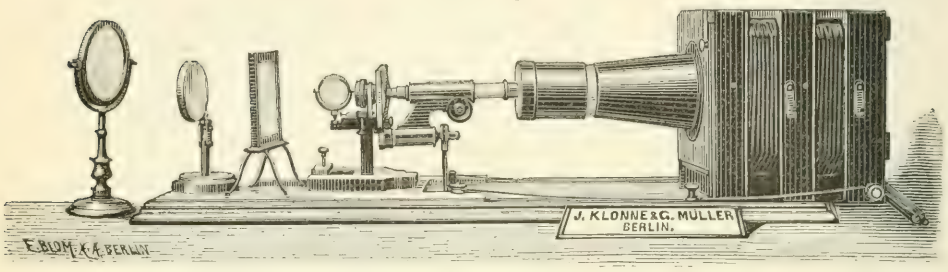
It consists of bellows $1\frac{1}{2}$ metre in length divided into two parts, so that one can be kept compressed when the other is completely extended, and it can be clamped at any desired length. The guides in which the

* Loc. cit.

bellows and its frames run are made to slide into one another, and when the camera is completely closed they can be placed under the base on which the Microscope stands, so as to be out of the way. The Microscope used for photomicrographic work is fixed to a slide which moves between guides on the base in such a way that the tube is horizontal, and is directed to the centre of the camera, the optic axis of the Microscope passing through the centre of the sensitive plate. The Microscope may at any time be removed, to be used for other purposes, and can be rapidly and easily clamped in the right position.

To adjust an object, the front of the camera which is nearest to the Microscope, together with the partly conical tube of 30 cm. length, which

Fig. 56.



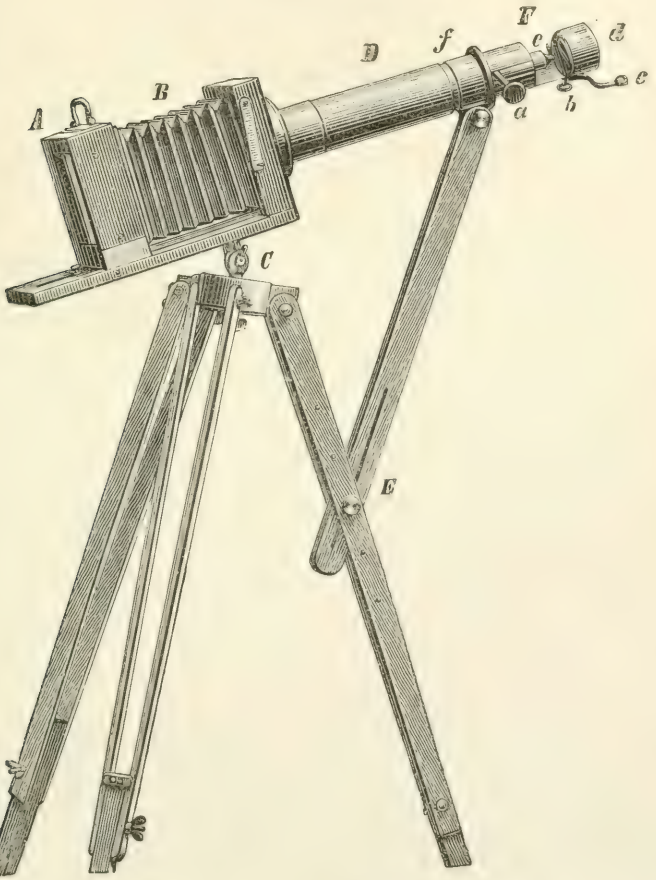
is provided with internal diaphragms, is drawn out, the Microscope is pushed in on its slide until its end approaches the aperture of the conical tube, the lamp or other source of light is then adjusted, and the object is adjusted in accordance with the directions of Dr. Neuhaus, which are supplied with the camera, the camera front is replaced and clamped, and the light-proof connection between the camera and Microscope is fixed in its place.

The fine-adjustment is effected by a curved forked clamp made of watch spring, the two ends of which take into the milling of the micrometer screw; two strings are attached to the clamp, and passing over pulleys on the right and left hand, traverse the whole length of the camera, and are fastened to a wooden rod; the strings can be rolled or unrolled upon the rod so that the latter always hangs in front of the camera. When the camera is drawn out the string is lengthened by unrolling it. By pulling upon the one string or the other the micrometer screw is made to turn to the left or right. In this way the fine-adjustment is made without any inconvenient connecting rods, and can be effected directly by one hand, while the other is engaged with the focusing lens; the motion obtained by the clamp on the micrometer screw is, it is claimed, quite fine enough to secure the complete sharpness of the image.

The plates which can be used are 13 × 21 cm., or half that size. With the arrangement of the source of light, illuminating lens, and Microscope described, impressions may, it is said, be taken of Bacteria × 1000 with an ordinary petroleum lamp and an exposure of a few minutes. With direct sunlight an exposure of a few seconds is enough even with the highest powers.

Stein's "Large Photomicroscope."‡—Dr. S. T. Stein's instrument (fig. 57) consists of a "parallactic" tripod, to which the camera B is attached by a ball-and-socket joint C. The triple tube D has a ring *f* connected with E, which has a slot by which it can be moved up and down on a pin in one of the legs of the tripod. The optical part is at F, consisting of an objective *e*, coarse-adjustment *a*, fine-adjustment *b*, and

Fig. 57.



condenser *d*. An arm at *c* carries a reflector or lamp. The apparatus can be extended so as to give a length of 1½ metres from A to *d*.

Photomicrographs of Diatoms.—MM. A. Truan and O. Witt have just issued a work beautifully illustrated by photographs taken from nature of the fossil diatoms from Jeremie, Hayti. Full details of the processes employed are given in the introduction.

The peculiarity of their method consists in first photographing the

* Stein's 'Das Licht im Dienste Wiss. Forschung,' 2nd ed. 1885, pp. 177–8 (1 fig.).

object with a magnification of not more than 100 diameters, and afterwards reproducing it magnified five times so as to obtain a photograph magnified 500 diameters proper for photo-printing. Fine details are thus brought out, invisible to the naked eye in the smaller photograph.

Crystal Palace Photographic Exhibition.

[Special Certificate in Class F. (General Appliances and Plant) "awarded to James Swift & Son for Apparatus and Microscopes arranged for Photo-micrography."]

Journ. and Trans. Phot. Soc. Gr. Britain, XII. (1888) p. 80.

Jeserich, P.—**Die Mikrophotographie auf Bromsilbergelatine bei natürlichem und künstlichem Lichte unter ganz besonderer Berücksichtigung des Kalklichtes.** (Photomicrography by the bromo-silver gelatin process with natural and artificial light, with special reference to the limelight.)

xiv. and 246 pp. (4 photomicrographs and 60 figs.), 8vo, Berlin, 1888.

Knösel's Photomicrographs.

[Note on some photomicrographs of animals and plants, taken by the oxy-hydrogen light.]

Zeitschr. f. Naturwiss., LX. (1887) p. 481.

(5) Microscopical Optics and Manipulation.

Advantages of a Knowledge of the Theory of the Microscope.—Dr. W. H. Dallinger writing * on the English translation of Nägeli and Schwendener's 'The Microscope in Theory and Practice,' says that it "opens to English readers an entirely new page in microscopical literature. It leads the way in supplying a want which every thorough microscopist has realized for the last twenty years. In a complete form this treatise has been accessible to the German reader for at least ten years. The absence of it, or an equivalent, in the English language has been a most serious drawback to the advancement of the highest optical work in English Microscopes. In optical manipulation, the English optician at his best proves not only equal to any in the world, but in the highest class of work, has shown lately that he takes a foremost place. But with no attempt on the part of English mathematicians and microscopists to become masters and expounders of the theory of the Microscope and of microscopic vision, the practical optician can make no real advance. English "stands," and those made in America on English models, are of exquisite construction, and are quite equal to our present necessities; but for all the great advances and improvements that have been made in *English* object-glasses during the last fifteen years, we are, for all practical purposes, primarily indebted to Germany. And this is readily explained by the fact that the German specialists have made a systematic and persistent study of the theory of the Microscope.

"It is not forgotten that it was to the suggestion of Mr. J. W. Stephenson that we are indebted for the invaluable improvements that belong to the homogeneous system of lenses.† But, without doubt, it was on account of the insight which a study of the theory of microscopic vision brought with it, that Mr. Stephenson perceived at once the advantages of great numerical aperture, and the new way to obtain it. Moreover, it is certain that Prof. Abbe was approaching this very method of employing lenses, though from another point, and not in so direct a way. It would have been shortly reached by him, there can be but little question; but when it was reached, what did a constant, enthusiastic, and laborious study of the theory of the Microscope carry

* Nature, xxxvii. (1887) pp. 171–2.

† See this Journal, 1878, p. 51.

with it? A perception, that with glass of greater range of refractive and dispersive indices than any we possessed, we might not only secure great numerical apertures, but secure them devoid of all colour; that we could not only annul the primary, but also the secondary and tertiary spectra. It need not surprise us then, that in a country where such splendid theoretical and mathematical work had been done by experts on the principles of microscopic lenses and the laws of their construction and use, even the Government should be convinced that the time to aid the optical expert had come; that theory had demonstrated the practical possibility of a great improvement in the construction of lenses. The sum of 6000*l.* was granted by the German Government to Abbe and his collaborateurs, and with, as we have reason to believe, an equivalent outlay on Abbe's own part, the new glass was prepared; and the new apochromatic lenses with their systems of compensating eye-pieces devised.

"It is in no spirit of boast, but rather in a spirit of humiliation and regret, that we say that we have examined many of these apochromatic objectives of all the powers made in Germany, and we have examined all the principal ones that have, since the new glass has reached London, been made there; and we are bound to say that the English work, based on the principles laid down by Abbe, is so fine as to make the regret immeasurably keener that English microscopical literature has been for all these years a blank for practical purposes, on the theory and principles of optical construction, and on the theory of microscopical observation and interpretation. Such a paper as that of Prof. G. G. Stokes, P.R.S., on the question of a theoretical limit to the apertures of microscopic objectives * from its very loneliness only gives emphasis and point to our contention. Those who have any doubt of the full force of what we are here contending for, have only to compare a dry 1/6-in. objective, say of twenty-five years ago, made by the best makers in London, with a well-chosen water-immersion of ten years ago; and both these with a recent homogeneous glass of the same power with a numerical aperture of 1·5. Or still better, a dry 1/50-in. objective, of the same date and the same makers, of numerical aperture 0·98, with a water-immersion lens of the same power of say ten years ago, having an aperture of 1·04, and a recent homogeneous 1/50 in., with a numerical aperture of 1·38. Still more strikingly, let the same observations be made with a dry 1/12 in. objective of twenty years ago, with a numerical aperture of 0·99, and a homogeneous lens of the same power, with numerical aperture 1·5; and finally, both these with an apochromatic objective of the same power by the same London makers, and an aperture of 1·40. We venture to say, to histologist, bacteriologist, diatomist, and all other serious workers with the Microscope, that there can be no proper comparison of the results; or, rather, the comparison is odious indeed for the oldest, and even the elder lenses.

"But, as we have stated, it is to Germany we are indebted for the knowledge out of which, alone, these improvements could have arisen. In spite of the length and abundance of English treatises on the Microscope, it has never been part of the scope of the respective authors to do other than make the scantiest reference to the principles of the Microscope; and nothing is found that will elucidate the theory of the

* See this Journal, 1878, p. 139.

construction of objectives, and eye-pieces, and the possible and real relations of each to the other. There is nothing to be found indeed in our language (except in the invaluable translations published in the successive Journals of the Royal Microscopical Society) which discusses the phenomena of diffraction, of polarization, of the principles of the true interpretation of microscopical images, and the theory of work with the Microscope. English workers with high powers have discovered painfully where their lenses during many years were at fault; they could show our opticians what they wanted; but it has been only as the result of the laborious mastery of the theory of lens-construction by German investigators, with Abbe at their head, that the English worker has been able to get his wants, in object-glasses and eye-pieces, supplied.

"But like all advances in insight and analytical power, these very improvements, so welcome and so helpful to searchers in many important branches of science, only open up the horizon of the unknown more fully; and the very knowledge we get, through the inestimable improvements, only reveals new difficulties; and again creates optical wants. It is then, with pleasure indeed that we hail this excellent translation of Nägeli's work on the theory and practice of the Microscope."

Fasoldt's Test-plates.—A good deal of amusement has been felt in the Old World at the vagaries of part of the New over these plates. As Old World microscopists are aware, it is one of the plainest and best established scientific truths that there is a limit to the number of lines to the inch that can be made visible to the human eye with our existing optical appliances, and to believe that more have been seen relegates the believer to the ranks of those who believe in perpetual motion, the creation of force, squaring the circle, and other self-demonstrated fallacies.

Our American brethren are not one whit behind us in their appreciation of scientific principles, and it was therefore puzzling to read from time to time positive statements that many people had seen 200,000 lines to the inch—the limit, even with the maximum aperture of 1·52, being 158,845. We put out of account the statements of the ruler of the lines, as he may be forgiven a not unnatural tendency to see lines that he feels certain his acknowledged mechanical skill has really put on the slide.

We gather that the explanation of these discrepancies is that the persons who are "ready to make affidavits" that they saw the lines are people who have had no practice in such observations, and it is well known how much the power of recognizing such minute magnitudes is dependent upon long habit and experience. It will be seen from the second report printed below that Dr. R. H. Ward, the well-known microscopist, has investigated the matter—under the superintendence of Mr. Fasoldt and his son—and that the results are in accordance with theory. The 110,000 band was seen with perfect ease, and the 120,000 clearly, though with difficulty, "while in higher bands no trace or suspicion of lines was perceived." Mr. Fasoldt himself "did not seem to recognize the lines nearly as far up in the series as this," while his son, who was the manipulator, could see nothing beyond 130,000. Dr. Ward further shows that the people who allege they have seen the higher bands admit that they "furnish only passing glimpses and cannot be kept in focus and examined at leisure or shown to other observers."

We have prefaced Dr. Ward's report by that of a Mr. P. H. Dudley,

which is a good specimen of the kind of evidence seriously put forward as sufficient to upset fundamental laws of light. It will be seen that Mr. Dudley was unable to resolve the 160,000, 170,000, and 180,000 band, but that "the 190,000 band came out sharp and clear. This was all he could do at that time!"

(1) *Dudley's Report on the Examination of the Fasoldt Test-plates.**—Mr. P. H. Dudley reports his examination (on an invitation from Mr. Fasoldt) of test-plates of his ruling, "as shown by his new vertical illuminator, lamp, and specially constructed Microscope." It was, he says, "an interesting and instructive evening." The stand was one constructed by Mr. Fasoldt, substituting a screw movement to the body instead of the ordinary rack and pinion. The vertical illuminator had, like Beck's, a thin glass for a reflector, but the method of mounting, construction of the diaphragms, and means to control the light, were "entirely different." The mechanical stage was constructed for the purpose of making fine measurements, and comparing micrometers. The eye-piece carried a micrometer, which had three delicate steel prongs in lieu of cobwebs, or lines on glass. Each prong was adjustable, extending partway across the field. One was in the upper part, and two in the lower part of the field. The advantages of the prongs are many, one being that but part of the line is covered. The lamp had a single wick, 2 in. wide. In trimming, the wick was curved from edge to edge; the centre being fully 1/8 in. higher than the edges. The chimney was specially formed of a metallic frame, carrying parallel plate-glass sides; those opposite the width of the frame about 3 by 4 in., and those opposite the edges 3 by 2 in. On the top of the frame was put a metallic tube, about $1\frac{1}{4}$ in. diameter, and 14 in. high, to produce the draught. The flame was large, and burned very white and steady. The lamp was placed from two to four feet from the Microscope, the edge of the flame being turned towards the illuminator, a small condenser, of 2 in. focus, being placed before the illuminator, so as to throw an image of the flame obliquely across the band of lines. The entire field was not equally illuminated, as better results are obtained by having different portions of different degrees of brightness.

Photomicrograph No. 1 shown by Mr. Dudley was of a test-plate having nineteen bands—said to have bands ranging from 5000 lines per inch, to the eighteenth, which has 120,000 lines per inch. The nineteenth band only has 50,000 lines per inch of the same depth of cutting as the eighteenth band. These bands all having been resolved, new plates were ruled, having finer bands.

Photomicrograph No. 2 was of a test-plate with bands in the metric measures. In one important respect the system of ruling on this plate was modified. Each band, for a short portion of its length, was only ruled with one-half of the number of lines in the rest of the band.

Photomicrograph No. 3 was of a test-plate having twenty-three bands; the highest having, it is said, 200,000 lines per inch. The ruling was very delicate, and the lines quite shallow, as must be the case. "Mr. Fasoldt says twelve persons have seen the lines in the last band, under his method of illumination, and with a Bausch and Lomb 1/12 in. objective, N.A. 1·35."

The first evening Mr. Dudley looked at the test-plates he saw the

* Journ. New York Micr. Soc., iv. (1888) pp. 81–4.

lines in the band of 130,000, clear and well-defined, after the instrument was focused. Unaided he was unable to go beyond the 90,000 band. This trial was made after a railroad trip of ten week-days and five nights. The vision was not as acute, and the touch of the fingers was not as sensitive as usual. In about a week afterwards, at a second trial, he "saw all of the lines to the 160,000 band, which he was unable to resolve." The 170,000 and 180,000 bands he "did not resolve, but the 190,000 band came out sharp and clear. This was all he could do at that time. The delicacy of focusing is probably as difficult as the discerning of the lines."

Photomicrograph No. 4 was of a quadruple ruling, the central bands being 80,000 per inch. When both sets of lines are illuminated, the spectra produced are gorgeous. "Mr. Fasoldt states that rulings which do not produce spectra are not resolvable, and he discards such rulings, as the lines are ruined."

"These rulings are of very great interest to the microscopist, as a measure of what can be done by different methods of illumination. After many trials by transmitted light, the band of 90,000 lines per inch was the most I could resolve. Mr. Fasoldt says the 110,000 band is the highest one he knows to have been resolved by the same 1/12 objective by transmitted light. It would be very interesting to know what kind of rulings Prof. Abbe used in determining the theoretical resolving power of an objective, as well as the method of illumination."

(2) *Dr. Ward's Report on the Examination of a Fasoldt Test-plate.*—Dr. R. H. Ward's report was embodied in remarks made at the Pittsburg meeting of the American Society of Microscopists. The following is furnished to us by the author:—

The plate consists of twenty-three bands ruled on a cover-glass, beginning at 5000 lines to the inch, and increasing by 5000 each time to 30,000, and thence by 10,000 each time to or toward 200,000. The lines are ruled alternately longer and shorter, so that the 40,000 band becomes at each end a 20,000 band with interlying lines, and the "200,000" band should be seen, if resolved at all, as a 100,000 band similarly interlined. The extraordinary mechanical skill of the maker and his success in ruling the lower bands attach real interest to the plate, and to his methods of studying it, in respect of the possibilities of fine ruling and of extreme resolution; an interest which is enhanced rather than diminished by the maker's easy faith in the character and visibility of the highest bands and his inability to apprehend the mechanical uncertainties and scientific absurdities involved in this belief. If he has done even a small portion of what he thinks, he has far surpassed all other experimenters, as far as yet proved, and has earned and will receive the credit that he claims.

Upon learning of the appointment of a committee to consider the subject, Mr. Fasoldt tendered a request that he might be allowed to be present when the plate was examined, and kindly offered the use of his apparatus, and also of his own services, "to show the lines" to the Committee at any time. Believing it to be of scientific as well as historic interest and importance to know exactly what he saw and how he saw it, I replied that while it would be impracticable for the Committee as a whole to make the proposed arrangement, as a member of the Committee I would gladly accept his offer to show the lines, and that the lines desired to be seen were those of the higher

band, from "120,000" upward. No objection was made to this form of acceptance.

At an appointed time, one afternoon, the Microscope was placed in a wooden cabinet which nearly excluded daylight, and light from a kerosene lamp, with a large flat wick, placed edgewise at a distance of about two feet, was admitted through an opening in a cabinet on a level with the nose-piece of the Microscope. The stand was a large and heavy one, made by Mr. Fasoldt himself, with about ten inches of tube-length, including the objective, and furnished with a Bausch and Lomb 1/12-inch hom.-imm. objective claiming 1·40 N.A., and a 1-inch "periscopic" ocular by the same makers. The illuminating rays were brought to a focus at the side of the nose-piece, and about one-fourth of an inch from it, by means of a "watchmaker's glass" of about two inches focus, mounted as a bull's-eye condenser, the best effect being gained with an achromatic one said to have been made for the purpose. The divergent pencil was then admitted to the tube, and reflected downward through the objective by means of a cover-glass internal illuminator claimed and patented by Mr. Fasoldt as his own. The peculiarity of this illuminator (aside from the oddity of its large size and square shape, the substitution of Fasoldt's spring nose-piece for the ordinary Society-screw to carry the objective, and an adjustment for withdrawing at will the cover-glass reflector from the optical axis), consists of an ingenious combination of shutters at the side, by means of which light is admitted only through a long narrow slit that is adjustable in both width and position. With this arrangement a variety of bright- or dark-field effects were obtained by slight changes in the position of the lamp and the adjustment of the slit. When the image of the illuminating flame was formed by the objective just at the edge of the field of view and slightly out of the plane of the object, a transparent effect was produced over a considerable portion of the field, presumably by internal reflection at the bottom of the dry-mounted cover-glass, on the lower surface of which the lines were ruled, and in the bright portion of the field the lines of the lower-middle bands were very easily and distinctly seen.

Starting from any of the coarser bands, where there could be no question about the lines, the plate was moved across the field by means of the steady mechanical stage, and the lines of successive bands appeared with distinctness, but increasing firmness, up to the band claiming 110,000 to the inch, which was seen with perfect ease, and the alleged 120,000 which was seen clearly and repeatedly, though with difficulty, while in higher bands no trace or suspicion of lines was perceived. The same limit was reached in several separate trials by the writer, whose eyes, however, by reason of long over-use, should set no limit against the reasonable claims of others presuming to go further. Mr. Fasoldt himself did not seem to recognize the lines nearly as far up in the series as this; but his son, Ernest C., who was depended upon for most of the manipulation, was positive that he saw the lines in the "130,000" band, and none beyond that. Any importance attached to his judgment at this interesting point must be received in connection with the fact that on another occasion he was satisfied that he resolved a "200,000" band. No attempt to measure the spacing of the lines was made at that time, and none is ready to report now.

Mr. Fasoldt's faith in the integrity and visibility of the still higher bands, which faith, it is scarcely necessary to say, is not known to be

shared by any scientific man, seems to depend wholly upon his belief in the infallibility of his carefully concealed method of ruling them, and upon his impression that he has seen the lines as high as "150,000," and upon the equally firm impression of a few other persons that they have seen all up to and including the "200,000." These persons, however, admit that the higher bands furnish only passing glimpses, and cannot be kept in focus and examined at leisure or shown to other observers, as can be done with more or less ease up to "120,000." Is it possible that, after looking long and intently at the coarse and really visible lines, the retinal impressions may remain and be recognized by the observer while subsequently gazing at the higher bands?

On another occasion, when it was claimed that all the bands of a duplicate plate were resolved, and that the illumination was exceptionally good and the resolution exceptionally easy, the writer, and two friends with younger eyes who accompanied him, recognized the lines of the 110,000 band very easily and distinctly, but failed to go further.

"It would be evidently improper to undertake to anticipate the action of the Committee as a whole, by saying exactly what should be considered sufficient evidence to establish the reality of certain of the lines and the fact of their resolution; but it will be noticed that the projecting alternate lines must greatly aid in the task of counting a measured portion of a band either with a micrometer or by aid of photography. It can scarcely be long impossible to make a satisfactory count of the band claiming to be spaced at 120,000 if it is correctly ruled, since the lines really to be counted are only at 60,000. And if, which is not improbable, though not yet formally demonstrated, this band should prove to be successfully ruled and to be resolvable by existing lenses, a fact that has been plausibly claimed but never yet really proved of any band of equal fineness, then the study of the next two bands would be one of the most interesting problems in the practical optics of the present day. At the same time, it seems not improbable that photography may not only give us an easy count of lines visible, but extremely difficult to count otherwise, but may yet show the details of bands that are permanently beyond the reach of direct microscopic vision."

With regard to Dr. Ward's last remark, we should remind our readers that, as we have already shown,* photography increases resolution in the inverse ratio of 53 to 40, the limit being raised from 158,845 to 193,037 lines to the inch.

Daylight or Lamplight for Microscopical Observation.†—Dr. W. H. Dallinger, referring to the fact that Nägeli and Schwendener give the preference to daylight over lamplight, believing that it exerts less strain upon the eye, says he suspects that the majority of English observers, especially at continuous work, and with high powers, will be inclined to reverse this judgment. Extremely white and intense light can be obtained from good modern lamps, and, unlike daylight, it is unvarying, devoid of caprice, and easy of manipulation. But this is a matter, perhaps, in some sense subjective, and not of vital moment.

Curious Interference Phenomena with Amphipleura pellucida.—Mr. E. M. Nelson writes:—"I have recently observed some remarkable interference phenomena in connection with photomicrographic glass

* See this Journal, 1885, p. 968.

† Nature, xxxvii. (1887) p. 173.

positives of *Amphipleura pellucida* × 730, the transverse striæ on which count 126 to the inch. The wooden case in which the positive is placed carries a Zeiss achromatic lens (No. 127) × 6, focused on the photograph.

The interference phenomena are as follows:—When the photograph is viewed through the lens, the illumination being of some extent, such as diffused daylight from a white cloud or wall, opalescent globe, &c., the transverse striæ appear as in fig. 58; but when the source of light is of smaller dimensions, such as a common Microscope lamp with a half-inch wick, the striæ are seen as in fig. 59.

Fig. 58.

Fig. 59.

This change of appearance cannot be accounted for by the non-admission of the pairs of diffraction spectra of either the 1st, 2nd, or 3rd order, because the angular divergence of the 1st diffraction spectrum from the dioptric beam is about as many minutes of arc as the lens has degrees of aperture.

Any moderate difference in the relative size of the striæ and interspaces would not alter the case, for Prof. P. G. Tait states that 'the ratio of the breadths of the bar and interstice has but little effect on the result unless it be either very large or very small.' Neither does it matter if the glass side or the film side is next the lens.

Now we come to a very curious point, viz. that other glass positives, printed from the same negative, do not possess the unique peculiarity which this one has. It is true that, by alteration of focus or other manipulation, the above and other diffracted images may be made; but I am aware of no object but this one that possesses the peculiarities above described. The negative from which this positive was printed does not exhibit the phenomena in such a striking manner, and then only by an alteration of focus.

I have another negative × 1200, which will show the effect, but the lens, which has a focus of $1\frac{1}{4}$ in., requires to be altered either 1 inch within or without its focus before it will show it."

Spectra of Pleurosigma angulatum.—This subject is a veritable *pons asinorum* to Mr. E. M. Nelson, who in a further note repeats the mistake on which we commented in this Journal, 1886, pp. 692–5, and which we then described as the most typical instance known to us of a critic being hoist with his own petard.

To understand Mr. Nelson's new note * it is necessary to recall the original one.

Mr. Nelson there † expressed his astonishment on two points. The first was that "the R. M. S." should be so foolish as not to see that Dr. Eichhorn's views on this subject "stultified Prof. Abbe's magnificent diffraction theory."

We pointed out that it was from Prof. Abbe that Dr. Eichhorn's paper was received, and that the problem solved was set by the Professor himself! It was therefore obvious that there was some little mistake somewhere in Mr. Nelson's views.

The second point was that Mr. Nelson declared (giving what he evidently considered irrefragable reasons for his assertion) that the mark-

* Engl. Mech., xlvii. (1888) p. 32.

† Ibid., xliii. (1886) p. 337.

ings in question could only be seen by *enlarging* the dioptric beam, and cutting out the six spectra.

Here, again, there was evidently something wrong in Mr. Nelson's ideas, as Mr. Stephenson used only a very *narrow* beam, and none of the six spectra were cut out.

In his new paper Mr. Nelson, never having revised his original premisses, falls into the old blunder over again. Referring to plate III. of the present volume of this Journal, he inquires "what has become of Dr. Eichhorn's fantastic diagram?" and "supposes that the officers of the R. M. S., since writing their strictures on my paper, have changed their minds, and have adopted Dippel's picture, which is similar to mine."

We are afraid that we shall only be adding to Mr. Nelson's present bewilderment when we point out that the fig. which he considers as "similar to his," was laid before the Society many years back, and that it emanated from the same authority as that of Dr. Eichhorn. Here again, therefore, there must necessarily be something a little defective in Mr. Nelson's ideas on the subject!

In our original comments we ventured to give a pretty broad hint as to where Mr. Nelson had gone wrong, but he does not seem to have yet found it out. The superficial way in which he approaches the matter may be judged of by the fact that he treats as a "dictum of the R.M.S." a statement in Prof. Abbe's original paper in Max Schultze's 'Archiv,' translated and published by the Bristol Naturalists Society! We are sure if he would only sit down with a serious determination to master the subject he would have no difficulty in finding where he has gone wrong, and having found it would then laugh as heartily as other microscopists do now at the absurdities into which he has allowed himself to be led.

Poli, A.—Sul modo di valutare ed indicare razionalmente gl' ingrandimenti del Microscopio e delle imagini microscopiche. (On the mode of determining and indicating correctly the amplification of the Microscope and microscopical images.) Extr. from *Spallanzani*, 1887, 11 pp.

„ „ Sulla misura dell' ingrandimento dei disegni degli oggetti microscopici. (On the measure of the amplification of the images of microscopic objects.) *Atti Congress. Naz. Bot. Crittog. Parma*, 1887, *Proc. Verb.*, pp. 109–13.

(6) Miscellaneous.

American Postal Microscopical Club.
[Satirical directions issued by the Club to meet new U.S. postal regulations.]
Queen's Micr. Bulletin, IV. (1887) p. 45. Cf. *Microscope*, VIII. (1888) p. 22.

Baltimore Microscopical Society. *Microscope*, VII. (1887) pp. 359–62.

Brooklyn Microscopical Society. *Journ. New York Micr. Soc.*, IV. (1888) pp. 96–7.

Central New York Microscopical Club. *Microscope*, VII. (1887) p. 364.

Crisp, F.—**Ancient Microscopes.**
[Friday evening lecture at Royal Institution on February 3rd, 1888.]
Daily News, Feb. 4, 1888; *Scientific Enquirer*, III. (1888) pp. 44–6; *Morning Post*, 1888, Feb. 4; *Scientific News*, I. (1888) p. 162.

Essex County Microscopical Society of New Jersey.
Journ. New York Micr. Soc., IV. (1888) p. 97.

Local Microscopical Societies. *Microscope*, VIII. (1888) pp. 18–20.

Louisville Microscopical Club. *Microscope*, VII. (1887) p. 364.

Mayall, J., Jun.—**Recent Improvements of the Microscope: a visit to Jena.**
19*th Ann. Rep. Liverpool Micr. Soc.*, 1888, pp. 8–11.

Medical Microscopical Society of Brooklyn.
Journ. New York Micr. Soc., IV. (1888) p. 97.

Microscopical Club of the Buffalo Society of Natural Sciences.
Microscope, VII. (1887) p. 364.

Microscopical Society of Pittsburg. *Microscope*, VII. (1887) pp. 362–3.

NELSON, E. M.—**Nobert's Bands.**
[Lines to inch in 10, 13, 15, 19, and 20 band plates.]
Engl. Mech., XLVI. (1888) p. 460.

Ohio State Microscopical Society. *Microscope*, VII. (1887) p. 363.

[OSBORN, H. L.—**Microscopical Societies should combine for work.**]
Amer. Mon. Micr. Journ., IX. (1888) pp. 35–6.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances.** XXXI., XXXII., XXXIII., XXXIV.
[Butterfly dust—Latticed and beaded Ribs—Researches in High-power Definition—Interferences, Disappearances, and Reappearances.]
Engl. Mech., XLVI. (1888) pp. 449 (6 figs.), 497 (2 figs.), 591 (5 figs.); XLVII. (1888) p. 93 (2 figs.).

St. Louis Club of Microscopists. *Microscope*, VII. (1887) p. 363.

SMITH, L. H.—**Memoir of D. S. Kellicott, Pres. Amer. Soc. Micr.**
Microscope, VIII. (1888) pp. 8–10 (portrait).

VEREKER, J. G. P.—**Presidential Address to the Postal Microscopical Society.**
Journ. of Micr., I. (1888) pp. 1–8.

VORCE, C. M.—**Making Lantern Slides.**
[Correction of his previous paper—see this Journal, 1885, p. 866—and full details of amended process.]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 172–4.

Wenham, Mr.
["Retired.—In a communication to the 'English Mechanic' of a late date Mr. Wenham, whose name is known to every microscopist the world over, announces that he has retired from microscopy; that he has given it up and has not looked through an instrument for several months, and has no expectation of ever doing so again. Mr. Wenham offers no explanation of his determination, but however painful it may be to the thousands who have learned to look upon him as one of the immortals in microscopy, from the tone of his letter we are convinced of his sincerity, and accept his dictum as final."]
St. Louis Med. and Surg. Journ., LIV. (1888) pp. 29–30.

WOOD, J. G.—**The Boy's Modern Playmate. A Book of Games, Sports, and Diversions.**
[Contains a chapter on "the Microscope," pp. 690–701, 14 figs.]
New revised ed., x. and 883 pp. and figs., 8vo, London, n.d.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Collecting, Growing, and Examining Fresh-water Sponges.†—In a contribution to a synopsis of the American forms of fresh-water sponges, Mr. E. Potts has some remarks on their collection and examination.

In *collecting* the author has found great advantage in the use of the "scraper-net" in relatively deep water, and in connection with perpendicular timbers, &c. This consists of a small net with one part of its edge shaped into a scraper like a garden hoe; it is attached to a long pole. At depths of two feet or less, great facility of action is gained by wearing high rubber boots, and wading after the specimens, to pick from the bottom stones, sticks or pieces of waterlogged timber, under which they may be concealed. Where the water is deeper, of course a

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Proc. Acad. Nat. Sci. Philad., 1887, pp. 158–84. Cf. also H. Mills in Microscope, vii. (1887) pp. 294–7.

boat must be used, to approach the floating, submerged, or dependent sponge-bearing substances. A large, strong knife or paper-hanger's scraper will be found convenient for hand work at short range. A case containing trays an inch or so in depth is suitable for carrying the smaller specimens; the larger will of course require vessels of greater size. On reaching home it is well to select some specimens of characteristic shapes, and containing gemmules, for storage in dilute alcohol, making use of wide-mouthed bottles to avoid crushing them. The rest may be spread upon boards in sheltered situations, in the shade (for the sun bleaches them rapidly) and left to dry; turning them every few hours to prevent decomposition. If time is limited or the specimens are large, artificial heat may be necessary; but whatever process is used, the drying must be *thorough*, or mould will soon cover the sponges with a mycelium which may be beautiful enough in itself, but is far from agreeable or sightly as a feature of the sponge. Whether they are to be dried or preserved in alcohol, they should be dealt with promptly, and on no account left to lie long in the water after being gathered. Preserve from dust in covered boxes.

Unless the sponges are large, it is difficult to detach them without mutilation from the rough surfaces of stones. It is therefore preferable to gather, when possible, those growing upon wood, which may be scraped or chipped without injury to them. It is essential to secure the very lowest portions, as it is there the gemmules often abide.

The proper season for collecting fresh-water sponges, in waters of the temperate zone, depends upon the purpose of the collector. If it is his desire to gather cabinet specimens merely, for the identification of old, or the determination of novel species, it is hardly worth while to begin before July. As with the flowering of plants, the maturity of different species of sponges is attained at various dates between midsummer and late in November. The essential point is that the gemmules and their armature shall be fully perfected; and when that condition is attained in any specimen, there is no reason for further delay.

The author would, however, "recommend to intending students a far higher object for their ambition—that is, the study of the physiology and life-history of sponges, as members of a sub-kingdom whose position has been greatly questioned, and whose character, derivation, and subsequent evolution are very important and perplexing topics." He would have such workers search for and examine them at all seasons of the year (even in midwinter, when he has never failed, in suitable situations, to find some in a growing condition), keeping memoranda as to each species separately, noting the date of their germination or earliest appearance, the location, elevation, and temperature, rapidity of growth at different seasons, time and manner of formation of gemmules, stability or decadence during the winter, modes of distribution and progression, whether always down stream or by other more adventitious methods, what becomes of the gemmules upon reaching salt water, and the thousand and one problems that go to make up the life-history of any animal form, and that in this instance have been very little studied. He is particularly anxious that some competent person should undertake their study in the briny, brackish, and the fresh-water lakes pertaining to what is known as the "Great Basin of the West," with a special view to ascertain the conditions under which they form "protected gemmules"

in such localities. By this means light may possibly be thrown upon the problem of their possible derivation from the marine sponges.

Great pleasure and profit may be attained in the same direction by *germinating the statoblasts* or gemmules under artificial conditions, and studying the development of the young sponges by the aid of as high powers of the Microscope as the ingenuity of each student may bring to bear upon the subject. He further recommends Mr. Carter's directions * for germinating statoblasts, which he considers will be found valuable.

"To obtain the young *Spongillæ* it is only necessary to get a portion of an old living specimen bearing statoblasts, and, having taken out a few (six to twelve) of the latter, to roll them gently between the folds of a towel to free them from all extra material as much as possible, place them in a watch-glass so as not to touch each other, with a little water, in a saucer or small dish filled with shot to keep the saucer upright and, covering them with a glass shade, transfer the whole to a window-bench opposite to the light. In a few days the young *Spongilla* may be observed (from its white colour) issuing from the statoblast and glueing the latter as well as itself to the watch-glass, when it will be ready for transfer to the field of the Microscope for examination, care being taken that it is never uncovered by the water, which may be replenished as often as necessary; but of course the object-glass (when 1/4 in. with high ocular is used for viewing the minute structure) must admit of being dipped into the water without suffusion of the lens."

His own first experience in the propagation of fresh-water sponges may prove instructive in various ways. Late in the autumn of the year 1879, in a pond within the Centennial Grounds, Philadelphia, he found for the first time a living sponge. It was a vigorous, branching specimen of *Spongilla lacustris*, charged with gemmules in all parts of its structure. A fragment firmly attached to a stone was taken home and placed in a gallon "specie-jar" with water, in the hope, begotten of inexperience, that it would continue to grow, exhibit its inflowing and exhalent currents, &c. On the contrary, almost necessarily, it died, and in a few days the water became insupportably foul. It was changed and another trial made, which resulted as before. This time the jar was thoroughly cleansed; the stone with the attached sponge was taken out and held long under the flowing hydrant before it was replaced in the jar, which was now left in an outer shed and, very naturally, forgotten. Weeks passed and winter came on, and one severe night the water in the jar was frozen solid and the vessel fractured. He supposed that the low temperature to which it had been subjected would prove fatal to the germs, but, as the specimen was a fine one, it seemed well to save it, even in its skeletonized condition. So when its icy envelope had been melted off, the sponge was again thoroughly washed until all the sarcode was removed, when in a fresh jar, it again became a "parlour specimen."

The author does not clearly remember when signs of germination were first observed. It was probably in January, as during that month artificial conditions very frequently bring about the hatching of such animal germs as those of the polyzoa, &c. He detected first a filmy, greyish-white growth, that seemed associated with the detached gemmules which lay in a groove around the bottom of the jar. A grey, feature-

* Ann. and Mag. Nat. Hist., 1882, p. 365.

less growth at first, then spicules were seen, in slightly fasciculated lines, attached to the glass and reaching upward, then spreading out fan-like and branching. These were, of course, covered with sarcode, nearly transparent at first, and through the filmy surface pores and osteoles could be detected with a pocket lens. The latter were surmounted by the so-called "chimneys" or cone-shaped extensions of the dermal film; and through the apertures at their summits effete particles could almost constantly be seen, puffed out, as if thrown from a volcano, and then blown off by the wind.

These products of single gemmules did not, as time passed on, greatly increase in size—possibly, because of a deficient nutriment in the unchanged water of the jar—but, crawling upward along the glass to an average height of an inch or less, left the naked spicules in place behind them as so many ladders or stepping-stones of their dead selves by which they had reached to higher things. Near the summit, one or more new gemmules would sometimes be formed, after which the mother mass entirely disappeared.

So much for the amount of growth from single gemmules. Where, however, they were thickly sown, or germinated *in situ* upon the stone, so that the contents of several could mingle and flow together, the resultant sponge was very much larger. The mass, if it may be so called, covered, at its best, nearly one-third the surface of the jar; while those gemmules remaining upon the stone and amongst the spicules of the old sponge continued to germinate, to form abundant sarcode and spicules, and, at least in one place, to throw out a long unsupported branch or finger-like process that ultimately reached a length of two or three inches.

Of course it was impossible to bring the higher powers of a compound Microscope to bear upon a sponge growing under such circumstances. A strong Coddington lens was the best that could be applied to this work; but a very fair share of success was obtained by the device of scattering small squares of mica among the growing gemmules, which, when covered by the young sponge, could be moved to the stage of the instrument, covered with water in a compressorium and examined comparatively at leisure. It was a perpetual cause of astonishment to see so large a production of silicious spicules from a single gallon of water, in which the chemist would probably have failed to find any such constituent. It is worthy of consideration however, whether such silica as composed the older spicules may not, at least when under the influence of the growth force of the younger sponges, be to some extent soluble.

For the determination of species the author gives a few general directions, which however he thinks will be soon modified to suit the taste or ingenuity of the worker. It is assumed that the investigator has already noted the general appearance of the sponge in hand; its colour, size, compactness, whether simply encrusting, or cushion-like, sending out finger-like processes, &c. These indications may help an experienced collector to a guess; but there are very few species that even such a one could name, with any confidence, before he had made and examined microscopical preparations of the same.

A stand, supporting a dozen or more test-tubes, say 3/4 in. in diameter by 1¼ in. in depth; a dropping-bottle containing nitric acid, and the usual material and apparatus for mounting in balsam are all the appliances

needed. As the processes to be described are certain to disturb the normal relations of the several classes of spicules to each other, it is well before the dried specimen has been much handled, to separate some clean portions of the outer or dermal film; lay them upon a slide and mount in balsam without further preparation. An examination of this may determine the presence and decide the character of the dermal spicules, if there are any pertaining to the species in hand. This precaution is necessary in view of the displacement of parts just mentioned, and also on account of the indiscriminating habit of the sponge-currents during life, which almost necessarily charge the tissues with various foreign particles, including vagrant spicules of its own and neighbouring species. In practice, the rightful presence of dermal spicules in any species is often so doubtful, that it can only be settled by an examination of young sponges, grown under observation from isolated statoblasts, whose identity has been satisfactorily determined.

Next, separate from the sponge some minute fragments containing skeleton spicules, the dermal and interstitial tissues, and a dozen or more gemmules. Place several of the last-named with a few adherent skeleton spicules upon the centre of a fresh slide; bring to the boiling-point in one of the test-tubes five or six drops of nitric acid, and by the aid of a dropping-tube apply a single drop of the hot acid to the gemmules upon the slide. While the acid is partially destroying their cellular or granular crust, pour the remaining fragments into the acid left in the test-tube and boil violently until all the tissues are destroyed and the spicules left as a sediment upon the bottom of the tube. Fill up the tube with water and stand it aside to settle, which may take an hour or more. The few minutes that have elapsed will probably have been as much as the gemmules upon the slide will bear; they must not be left so long as to destroy the chitinous coat, nor is it well, though a common practice, to *boil them upon the slide*, for this often smears and disfigures it with frothy matter. Remove most of the acid by trickling drop after drop of water over the slide while held in a slightly inclined position. Wipe off all the water that can be reached and apply repeated drops of strong alcohol to take up the remainder. When this is so far accomplished that the gemmules will absorb benzole freely and receive their covering of benzole and chloroform balsam without *clouding*, apply the balsam and a cover-glass. This process of removing moisture by the use of alcohol, rather than by drying over a lamp, is to be preferred, although it requires more care and time, because the gemmules are less likely to be distorted in shape and the cells of the crust to become filled with air if they are kept always under fluid. Yet if the mounted gemmules, when examined, appear black, showing an accidental intrusion of air, much of this can be removed by carefully heating the slide over a lamp.

If this mount has been successful, the gemmules are now so transparent that their surrounding spicules can be readily seen and the genus determined; but a better view of the detached spicules is necessary, and may be obtained by mounting some of the contents of the test-tube. If the lately suspended spicules have now settled, carefully pour off all the water except one or two drops, though if there has been much acid used it may be better to wash them a second time. Shake up and place a sufficient quantity upon one or more slides, being careful not to leave the contained spicules in too dense a mass. It is best to allow the water

to evaporate from these slowly, as, if hurried over a lamp, each spicule is often margined with minute globules that it is impossible afterwards to remove. However, when the slide is apparently quite dry, it may be safely exposed a moment to the heat to make sure of it, and then covered with balsam and glass as usual.

The author adds:—"The investigator has now before him all the elements necessary for solving his *specific* problem, according to the formulæ which follow:—The normal sponge, the dermal film, the transparent gemmule, and a display of the detached spicules. Neither would alone answer, but the series will settle all points, excepting in the case of the genus *Carterius*. When this is suspected, the gemmules should first be examined *dry*; and, in preparations for mounting, great care should be taken to avoid the destruction of the tendrils (cirri), by the prolonged use of strong acids. Expert microscopists will improve their gemmule mounts by dividing some of them with a thin knife, endeavouring to make the section through the foraminal aperture; this, in the case of species having long birotulates, such as *Myenia crateriformis*, is of the utmost importance.

"'Seniors' in microscopy will please pardon the minutiæ of the processes just given, as they were necessary to make them available for the freshmen. All are reminded that the above directions as to collection and examination refer to mature sponges only. It is seldom safe, or even possible, to *name* one in which no gemmules can be found. If a course of study is undertaken, involving the histology and physiology of fresh-water sponges, many peculiarities will of course be observed that have not been alluded to here. One of them concerns the development of the spicules, and, if not understood, will pretty certainly mislead the beginner into the supposition that he is examining a novel species. Both the skeleton and the dermal spicules of *young sponges* are frequently marked with bulbous enlargements at the middle, and often half-way between the middle and each end of the spicule. These seem to indicate an immature condition, as they disappear when the spicules are fully formed."

Potato Cultivations.*—Dr. J. Eisenberg, instead of using solid pieces of potato, employs a mash. The potatoes are first well cooked by steaming, and then pounded in a mortar. The mashed potato is then pressed down into small glass pans about 5 cm. in diameter. The pans are provided with a lid in which there is a groove, so that the cover may fit accurately. The pans are then sterilized for three successive days, for half an hour a day, in a steam sterilizer. When required for use, the cover is lifted up and the surface inoculated. To make the pan air-tight, it is only necessary to turn it down on the cover, and run some melted paraffin round the angle between the lid and the pan. If there should be any condensation water on the lid this can be got rid of by passing the pan through the flame of a Bunser's burner two or three times.

Sterilization of Potato, Apples, and Water for cultivation purposes.†—Dr. H. Plaut first sterilizes three or four test-tubes (3 cm. broad and 20 cm. long) which have been plugged with cotton wool in the usual way. Potatoes are then peeled with a clean knife, while apples

* Centralbl. f. Bakteriol. u. Parasitenk., iii. (1888) pp. 216–7 (1 fig.).
† Ibid., pp. 100–1, 126–8 (1 fig.).

are merely washed clean. Cubes of apple or potato, sufficiently large so as not to interfere with one another in the tubes, are then cut up. About eight of these cubes are able to be put in each tube, and the latter having been plugged with cotton wool, are placed in a steam sterilizer for half an hour. When cool, transfer to a well-closed jar, upon the bottom of which some water must be poured from time to time. Here they may be kept for quite a month. Thus, after sterilization, is obtained from four tubes material sufficient for 32 Koch's jars. Each cube is removed to a separate test-tube or jar by impaling it on the bent end of a piece of platinum wire previously thoroughly heated. Some practice is needful for this, as the cubes are apt to slip away. The cover of the jar may be held up by an assistant, or more simply the whole manipulation may be affected as described by the author in Zürn's 'Parasiten,' 2nd edition, ii. p. 165. The apple-cubes, which the author uses for cultivating all kinds of Saccharomyces, become soft as jelly after sterilization, and are only held together by the peel. Hence manipulation of them is somewhat troublesome, but if any irregularity of surface occur, this may be removed by smoothing it down with a previously heated spatula.

To obtain and keep a quantity of water that shall be free from fungi, the author takes an ordinary flask; this is three-parts filled with water, plugged with cotton wool, and sterilized. The rubber tube and the glass stoppers are then fitted in and plugged round with cotton wool. The apparatus is then placed in a steam sterilizer for half an hour. When cool, the one end is fitted with a rubber spray bellows, and the other supplied with a pinchcock. When to be used it is necessary to squeeze the bellows twice before opening the pinchcock, and to close the latter before the stream of water has ceased.

ARLOING—**Modification apportée à un analyseur bactériologique.** (Modification in a bacteriological analyser.) *CR. Soc. Biol.*, 1887, p. 722.

DAL POZZO, D.—**Das Eiweiss der Kiebitzeier als Nährboden für Mikroorganismen.** (The albumen of the plover's egg as a culture medium for micro-organisms.) *Med. Jahrb.* (*Wien*), 1887, pp. 523–9.

FISCHL, R.—(*a*) **Ein neues Verfahren zur Herstellung mikroskopischer Präparate aus Reagenzglasculturen**; (*b*) **Die Anfertigung von wirksamen mit Mikroorganismen imprägnirten Fäden.** ((*a*) A new process for making microscopic preparations from test-tube cultures; (*b*) the preparation of threads effectively impregnated with micro-organisms.) *Fortschr. d. Medicin*, 1887, pp. 663–6.

ROUX, E.—**De la Culture sur Pomme de terre.** (On potato cultivation.) *Ann. Instit. Pasteur*, 1888, pp. 28–30.

(2) Preparing Objects.

Demonstrating the Reticulated Protoplasm in the Interstitial Cells of the Ovary.*—M. N. Löwenthal remarks that it is not rare to meet in sections of ovary of dog, cat, or rabbit, with interstitial cells, the body of which appears to be subdivided by a protoplasmic network more or less restricted to small areas of round, oblong, or polygonal shape. This special conformation of the interstitial cells is particularly frequent and easy to demonstrate in the cat. It is due to the fact that the cell is infiltrated with globules which stain black, not only with osmic acid, but with chrom-aceto-osmic acid. The globules are particularly large in the cat; much smaller in the rabbit. They are

* Arch Sci. Phys. et Nat., xviii. (1887) pp. 558–9.

disposed with much regularity all round the nucleus. As they increase in size they almost touch, and in consequence the protoplasm proper is reduced to a delicate framework.

The procedure for showing the structural peculiarities of the interstitial cells consists in fixing the pieces in the chrom-aceto-osmic acid mixture, and staining the sections after Flemming's method with safranin. After dehydration the sections are placed in oil of turpentine. By this means the globules blackened by the osmic acid are for the most part dissolved; in those that remain the intensity of colour is much diminished. Sometimes the cell assumes a more or less deep lilac tint.

Methods of investigating Structure of Nerve-tissues.*—Mr. F. Nansen, in his studies on the structure of nervous tissues, made use of fresh isolated tissues, as well as of those that had been macerated or cut into sections. The first were examined in the blood of the animal from which they were taken, either as large pieces or after being teased with glass-needles, the use of which the author strongly recommends. For macerations use was made of B. Haller's fluid composed of 5 parts acetic acid, 5 parts glycerin, and 20 parts distilled water; pieces were treated with this for from one to twenty-four hours, then teased in 50 per cent. glycerin, or washed and stained with ammonia-carmine or picro-carmine. Delafield's solution is specially recommended. For some purposes it was better to macerate in dilute alcohol, when weak solutions (17–20 per cent.) were found good. Sometimes, however, this process has to be continued for weeks; when finished, the tissues were stained in ammonia-carmine diluted with an equal quantity of macerating fluid for twenty-four hours, and teased in glycerin of 50 per cent.

The author usually stains before teasing or isolating, because he thinks it much more practical, and when one is careful not to employ too strong solutions, and to dissolve or dilute the staining colours in the macerating fluid, the facility of isolation is not seriously disturbed. Though one of the oldest methods, that of maceration in potassium bichromate is one of the best, and must never be omitted when it is wished to examine the most delicate structure with good results.

The most important thing in researches on the histology of the nervous elements is to get good sections from well fixed and stained preparations. The author strongly recommends Flemming's mixture as made of 15 parts of 1 per cent. chromic acid, 4 parts of 2 per cent. osmic acid, and 1 part (or less) of acetic acid. Pieces as small as possible must be treated in not too small quantities of the fluid for from 12–24 hours, or even longer. After washing they should be directly inclosed (not imbedded) in paraffin, and may then be easily cut under alcohol or water. Mr. Nansen has succeeded in getting sections only 0·005 mm. thick.

A method which was found very useful with Mollusca was the following:—The pieces for examination, cut as small as possible, were treated with 1 per cent. osmic acid for 48 hours, then washed in running water and cut at once by hand, or with the microtome (or they may be first hardened in alcohol and then cut). The sections were stained in Delafield's hæmatoxylin (diluted), and the colour destroyed in water containing a little acetic acid; the sections were examined in glycerin

* Bergens Museum Aarsberetning for 1886 (1887) pp. 73–80.

or Canada balsam. By this method the fibrillar substance got a distinct blackish staining.

Mr. Nansen concludes with describing a method the importance of which "for our future knowledge of the nervous system can scarcely be overestimated, as it affords really quite marvellous preparations, and far surpasses every method hitherto known." By modifications of the black chromo-silver method of Prof. Golgi the author has obtained excellent preparations. As employed for *Myxine glutinosa* the following method is adopted:—The nerve-cord is cut out of the living animal, and divided into pieces one or two centimetres long; these are laid in a solution of potassium-bichromate (2–2·5 per cent.) for about an hour, when the solution is changed and made a little stronger. In this the pieces are left for about twenty-four hours, after which they are put into a fresh solution consisting of 4 parts of 3 per cent. solution of potassium-bichromate and 1 part of 1 per cent. osmic acid, in which they remain for about three days. When the pieces are ready, they are directly treated with silver nitrate; they are first washed in a weak solution (0·5 per cent.), and then placed in 1 per cent. solutions. After one day the staining is generally complete. Sections need not be very thin; if the staining is good the ganglion-cells will be seen with all their processes, and nerve-tubes with their ramifications will appear quite dark or black on a transparent field.

Specimens intended to be preserved should be washed well in alcohol of 90 to 96 per cent.; when sufficiently washed they should be placed in absolute alcohol. After some hours of this the sections are placed in pure turpentine, which must be changed several times; and they are then placed on the slide in dammar-resin dissolved in turpentine. If it is desired to keep the preparation a long time, it must not be protected by a cover-glass; the dammar is at once dried in a warm bath or incubator, when the turpentine is very rapidly evaporated and the dammar becomes quite hard and smooth. The addition of a cover-glass prevents, of course, the evaporation of the turpentine and other volatile oils.

Prof. Golgi mounts the sections, in dammar, on cover-glasses, and the cover-glasses are again mounted on wooden slides, in the middle of which square apertures are cut to suit the glasses. This excellent method not only admits of the use of oil-immersion lenses, but allows the sections to be examined from both sides, which is often of great importance when the sections are thick. Silver-stained preparations should, of course, be kept in the dark when not being used.

New Method for Investigation of Blood.*—Dr. D. Biondi describes a new method for the microscopical examination of the blood. He notes the disadvantages of the methods hitherto practised. Being desirous to study the blood more intimately, by means of sections, he experimented with all sorts of imbedding mixtures without success. Eventually, he fixed the elements by placing drops of fresh blood in 5 c.cm. of 2 per cent. osmic acid solution, and this achieved the first step. The imbedding was successfully effected, after many attempts, in agar-agar, so much used by Koch and other bacteriologists. The mixture of blood and osmic acid is placed in dissolved agar at a temperature of 35°–37°. The fluid is allowed to harden in the usual moulds, is sliced into little portions, placed for some days in 85° alcohol, and cut in pith. The

* Arch. f. Mikr. Anat., xxxi. (1887) pp. 103–12.

agar method may also be combined with the usual paraffin process. He gives further details as to staining, clearing, and the like, but the point of importance is the successful results of this agar imbedding for the purpose of minute morphological study of fine elements like blood-corpuscles.

Methods of studying typical Bird's Feather.*—Mr. R. S. Wray came to the results which he has reached with regard to the structure of a typical pennaceous feather, while preparing a model for the Natural History Museum. A feather was soaked in turpentine and bits of the vane were cut out and mounted in Canada balsam to show the upper and lower surfaces. Separate barbs were mounted, the barbules on some being teased out with needles, and on others the barbules were cut off by placing a sharp razor on the sides of the barb and pressing gently on the slide, when sufficiently perfect barbules of each kind were obtained for examination. Portions of the vane were carefully imbedded in paraffin, and sections mounted by the creosote-shellac method, so that the parts were obtained in their relative, natural, and undisturbed positions. In addition to transverse and horizontal, sections parallel to the distal barbules were made. A gutta-percha model illustrating the points elucidated by Mr. Wray, is to be seen in the "index-museum" of the Natural History Museum, and is worthy of the attention of microscopists.

Mounting Tape-worms.†—Mr. W. S. Jackman states that a joint or segment of tape-worm mounted in the following manner will show the ovaries and eggs very clearly.

Procure good-sized specimens with well-filled ovaries. Remove the alcohol in which they have been hardened, wash and immerse in glycerin for a few days until clear and pulpy in appearance. Place between two strips of glass and squeeze until the specimen is quite thin. Clamp with a stiff spring and allow it to remain thus for several hours—a day is not too long; sufficient glycerin will adhere to the glass to keep it moist. Next place it in the stain, a few minutes will usually be long enough; pass it then through the fixing solution and place in oil of cloves, allow it to remain here until the tissue around the eggs assumes a transparent glassy appearance, then remove to a thin balsam solution and mount. Turpentine should not be used for clearing, as it makes the specimens opaque. "Hard finish" answers as well as balsam, is pleasanter to handle, and easier to prepare. It should be thinned with benzol and then filtered.

Reeves's Method.‡—Mr. R. N. Reynolds states that by following Dr. J. E. Reeves's method of preparing, cutting, and mounting pathological specimens he has now great success. The sections are 1/4000 in. thick, but only about half or one-third come from under the flattener in a condition to mount. Instead of balsam he uses Berry Bros'. oil finish. Sections 1/2000 in. thick came out straight enough for mounting. The chief difficulty in the method arises from not using sufficiently hard paraffin. The author found that the hardest refined paraffin of the Standard Oil Company, Cleveland, supplied the want, but in very cold weather a softer variety could be used. If the

* Ibis, 1887, pp. 422–3.

† The Microscope, viii. (1888) pp. 5–6.

‡ Ibid., p. 31.

specimens remain cloudy after liberal use of absolute alcohol, this is due to insufficient immersion in the turpentine bath.

Mode of rendering visible the closing Membrane of Bordered Pits.*—Herr A. Zimmermann recommends for this object staining with hæmatoxylin (in Böhmer's solution), and clearing with oil of cloves and Canada balsam. If slightly tinged, the "torus" alone then takes up the pigment strongly, while all the other membranes are almost entirely colourless. By this method the torus is rendered visible even in relatively thick sections and with low magnification.

Mounting small Organisms—Disaggregation of Rocks.†—Sig. D. Pantanelli who recently suggested a method for mounting small organisms found in the residues from finely divided rocks, by using a mixture of collodion and oil of cloves, has, on account of the impurities in the latter, and the difficulty of making elegant preparations, now substituted for it salicylic ether ($C^9H^{10}O^3$), which, on being evaporated at a temperature of 60°, leaves the collodion unaltered, while at ordinary temperatures it keeps viscid sufficiently long for making the preparation.

Tempère advised that rocks refractory to acids should be disaggregated by boiling them in a concentrated solution of sulphate of soda, the act of crystallization completely breaks up the rock; when used for diatoms this method succeeds very well with porous rocks, and serves excellently for separating out the foraminifera from argillaceous or calcareous rocks, which are not reduced by repeated immersion in water. Having experimented with porous, calcareous, and compact argillaceous rocks, the author has succeeded in separating out, without damage, the most delicate foraminifera, and still more easily radiolaria and diatoms. Whenever siliceous organisms are sought for, the acid process should be adopted, and whenever this fails to break up the rock, the solution of sulphate of soda should be tried.

KÜHNE, H.—**Ueber ein kombinirtes Universalverfahren, Spaltpilze im thierischen Gewebe nachzuweisen.** (On a combined universal process for demonstrating bacteria in animal tissues.) *Dermatol. Studien* (Unna), 1887, pp. 9–14.

MANTON, W. P.—**Rudiments of Practical Embryology, being working notes with simple methods for beginners.** *Microscope*, VIII. (1888) pp. 15–8.

(3) Cutting, including Imbedding.

Application of Paraffin Imbedding in Botany.‡—Dr. J. W. Moll enthusiastically recommends paraffin imbedding for botanical preparations. The reasons given why this method has not hitherto been more generally adopted are that tissues preserved in alcohol are unsuitable, and that it has usually been tried with full-grown parts, for which it is not so well adapted.

The procedure is as follows:—Take, say, fresh tips of some primary or secondary root 1–2 cm. long, and fix in watery 1 per cent. solution of chromic acid, or a saturated solution of picric acid, or, best of all, a modified Flemming's mixture (chromic acid 1 per cent., osmic acid 0·02 per cent., acetic acid 0·1 per cent.).

Herein the root-tips remain for twenty-four hours, and then the acids

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 216–7.
† Atti Soc. Tosc. Sci. Nat., vi. (1887) Proc. Verb., pp. 12–13.
‡ Bot. Gazette, xiii. (1888) pp. 5–14.

are to be thoroughly washed out with running water. The water is then replaced by alcohol, which must be added gradually in increasing strengths of 20, 40, 60, 80, 95 per cent., to prevent it swelling. The alcohol is next replaced by a solvent of paraffin, turpentine being the best. This is performed gradually, first with equal parts of alcohol and turpentine, then with pure turpentine; then transfer to a cold saturated solution of paraffin in turpentine; then to equal parts of turpentine and paraffin kept at a heat of 30°–40° C. After an hour the temperature is raised to 50°–55° C., and the roots finally placed in pure melted paraffin renewed once or twice. In about six hours the roots will be thoroughly permeated, and then they are placed in rectangular moulds suitable for being held in a microtome clamp. The inner surface of the moulds should be wetted with turpentine before the melted paraffin is poured in, and as soon as the molten mass is cooled so far that a film is formed on its surface, cold water should be at once poured over it, as sudden setting of paraffin prevents the formation of cavities. After the sections are made they are glued to the slide with indiarubber solution, albumen, or collodion; the two last are to be preferred. If albumen, equal parts of white of egg and albumen are mixed together, some drops of carbolic acid added, and the whole filtered. If collodion, then a mixture of equal parts of collodion and oil of cloves is made. In either case the slide is painted with the adhesive, the section pressed thereon, and the slide is then heated in the oven for fifteen minutes at 50° C. While still warm the slide is transferred to turpentine, which dissolves the paraffin, and the turpentine removed by means of alcohol.

The specimens may be stained before imbedding or as sections on the slide. If the former, then Grenacher's alum-carmine when the specimens have reached the 60 per cent. alcohol stage; if the latter, then alum-carmine, hæmatoxylin or the anilins, the last being specially suitable for demonstrating karyokinesis.

The sections may be mounted in glycerin or balsam, but the latter is preferable.

New Imbedding Material.*—Prof. E. Pfitzer describes a new mode of imbedding, which he has found very useful in the examination of minute and very soft or thin parts of plants, such as the flowers of orchids in early stages of their development. The principal objects were to obtain an imbedding material which should combine solubility in water with a great degree of transparency. These properties are presented by glycerin soap.

Prof. Pfitzer heats in a water-bath of a temperature between 60° and 70° C. a mixture of equal volumes of glycerin and 90 per cent. alcohol, with as many minute yellow transparent pieces of glycerin soap as will dissolve in it. This is best done in a cylindrical vessel stopped with cotton wool, from which but little alcohol evaporates. The yellow perfectly transparent or only slightly turbid fluid is poured either into a flat dish or into a paper cup made by wrapping strips of paper round a cork and fastening with a pin, the paper having been first saturated with strong alcohol. While the mixture is hardening, the object must be placed by a needle in a position suitable for making sections. With larger objects it is convenient to insure perfect saturation by laying them in a cold saturated solution of soap before transferring into the

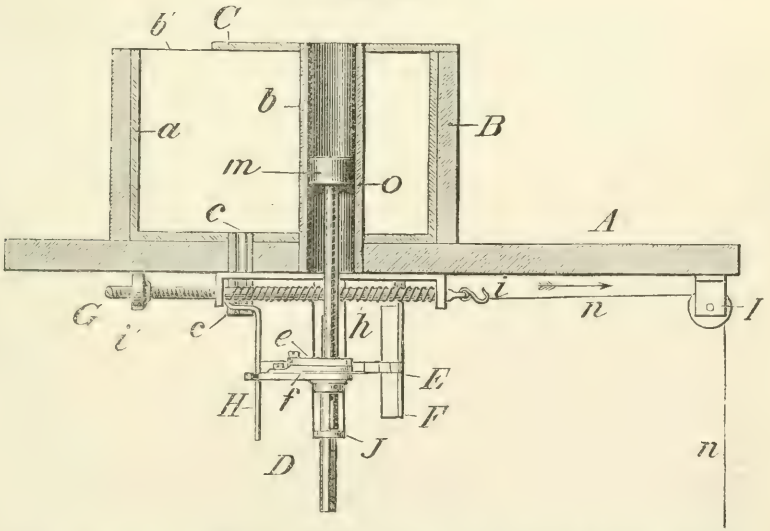
* Ber. Deutsch. Bot. Gesell. (Gen.-Versamml. Heft) v. (1887) pp. lxv.–viii.

hot mixture. The imbedding substance can be preserved cold in corked vessels for an indefinite time, and will melt at a temperature of about 40° C.

By this means perfectly clear transparent imbeddings may be obtained, which can be cut with the greatest ease after hardening in the cold, and can be preserved unchanged in a vessel over fused calcium chloride, which renders them somewhat harder and therefore better. Very minute objects may be imbedded still more quickly by placing drops of the material on a cork, laying the object on them, and adding another drop of the material. Small quantities of the solution of soap harden completely in a quarter of an hour. For harder parts of plants the process is not very convenient, the material being not sufficiently solid; paraffin or celloidin are better. For making the sections Thoma's slit-microtome was used.

Dale's Microtome.—Mr. H. F. Dale has patented the microtome shown in figs. 60 and 61, the primary object he had in view being "to provide an instrument which, while it may be made at comparatively

FIG. 60.



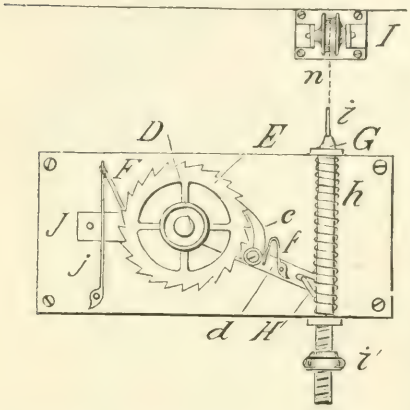
small cost, shall be effective and durable to the highest degree possible, and which particularly distinguishes itself also owing to the facility with, and advantageous manner in which it is operated."

The device comprises a base-plate A, upon the surface of which is fixed a rectangular box B, having a freezing chamber *a* perforated at the bottom with two holes, into the larger of which is secured a tube *b*, which contains the object. The smaller perforation is provided with a short length of tube *c*, which serves to drain off the liquefied refrigerant. On the top of the box B is a face plate C, partially covering the box, the open portion b^1 allowing of the introduction of the refrigerant.

The mechanism for raising the object comprises a spindle D, to the centre of which is fixed a rachet-wheel E, into the teeth of which a

pawl *e* takes, carried upon an arm *d*, the pawl being pressed against the rachet-wheel by a small bent spring *f*. The arm *d*, which works loosely upon the spindle D, is kept in its proper position by means of a washer; the extremity of the arm is forked, into which takes a bent wire H, fixed to a rod G, working horizontally in bearings. Within the bearings the rod is surrounded by a spiral spring *h*. To one end of the rod, beyond the bearing, is a small hook *i*, to allow of the attachment of a cord, which, passing over the small pulley I, is secured to a suitable treadle beneath the table. The other end of the rod has a screw-thread with a thumbscrew i^1 for regulating and limiting the horizontal motion or "play" of the rod.

Fig. 61.



To the base plate A is fixed a second pawl F, of such length as to act upon the rachet-wheel E at whatever height the latter may be, the pawl being gently pressed against the rachet-wheel by the spring *j*. The upper part of the vertical spindle D has a fine screw-thread, which works in a metal disc screwed to the base plate. The other extremity of the spindle is plain, and moves freely in a bearing formed in a rigid bracket J, which serves to keep the spindle perfectly central relatively to the tube *b*. The spindle terminates at its upper extremity in a conical point *o*, upon the apex of which is a plug *m*, which moves freely up and down in unison with the vertical motion of the spindle.

The mode of working the apparatus is as follows:—Having adjusted the thumbscrew i^1, the treadle is depressed, and by means of the cord *n* attached to the rod G, the latter is drawn forward in the direction of the arrow, a distance limited by the position of the thumbscrew i^1, and in this forward motion carries with it, by means of the wire H, the arm *d*; whereupon the pawl *e* takes into the rachet-wheel E and rotates the latter a distance corresponding to one, two, or more teeth, thus raising the plug *m* and object to such a height as to allow of a section being taken in accordance with the thickness desired. The whole of the mechanism, it will be seen, is actuated by the depression of the treadle, thus leaving both hands free to manipulate the knife, as also to vary the position of the object.

The author, in his specification,* further says:—"It is well known that in preparing objects for microscopic examination, it is almost impossible, by the methods at present generally adopted, to obtain very thin sections or slices of substances of a brittle or non-elastic nature. This difficulty is, to some extent, due to the inability to utilise both hands for manipulating the razor or section knife before referred to, but with the improved apparatus above described, inasmuch as the

* 1887, No. 9900.

mechanism is actuated by the foot, both hands are available to give to the cutting knife those exact movements so essentially necessary to the successful production of extremely fine, thin, delicate films; therefore the brittle substances having been treated in any of the usual ways to impart tenacity and partial elasticity thereto, the knife is made to approach and cut into the substance of the object, either direct, diagonally, or in any other desired manner, without fear of one part of the film or slice being of greater thickness than another, a most important consideration with respect to opaque or semi-opaque substances. Another important feature in the device arranged as above described, is the rigidity with which the object to be operated upon is maintained in position during the process of cutting or slicing the same, as the means for imparting motion being situated at a distance from the mechanism, and the latter inclosed if desired in a protective case or box, the risk of movement, or shifting of the substance from which a film is to be cut, is rendered impossible."

(4) Staining and Injecting.

Staining Cultivation Media and its results on micro-organisms.*—Dr. G. D'Abundo's object in staining cultivation media with various dyes was to attempt to ascertain if any new biological characteristics could be imparted to the micro-organisms cultivated thereon, and, if possible, to stain the spores. The media were distilled water, peptonized broth, gelatin, agar, and potato; the dyes were methylen-blue, fuchsin, and methylen-violet. Sterilization was performed in the usual way. The results were as follows:—

Distilled water and methylen-blue; typhoid bacillus grow feebly, but were stained, the water being unaffected. Similar results were obtained with fuchsin, methyl-violet, and Bismarck brown. Peptonized broth coloured as above becomes decolorized, but the bacilli are unaffected. If the test-tube be shaken the colour returns. Stained with fuchsin the broth gave similar results; but with methyl-violet the bacillus grows slowly, but is stained. Pneumonia coccus gave similar results; that is, it was stained with methylen-violet, but not with other dyes. Anthrax seems to have stained in the blue-violet and red anilin if the medium were deeply stained. On gelatin stained with methylen-blue typhoid bacillus developed a colour, and this was demonstrated microscopically. Bismarck brown and methyl-violet gave similar results, but fuchsin failed. Pneumonia coccus only developed a faint colour when the medium was highly charged with pigment. On agar the typhoid bacillus is coloured with methylen-blue and methyl-violet, but not with fuchsin. On potato, coloured with methylen-blue, typhoid bacillus developed a hue much deeper than the cultivation medium; but there was no result with fuchsin.

Nitrate of Silver Method.†—Sig. C. Martinotti proposes the following improvements on the method of staining with nitrate of silver:—(1) increase the volume of the silver solution in proportion to that of the object to be stained; (2) increase the duration of immersion (15–30 days); (3) maintain the objects at a temperature of about 25 degrees for ganglionic cells, or if for neuroglia cells alone at 35–40 degrees;

* Atti Soc. Tosc. Sci. Nat., vi. (1887) Proc. Verb., pp. 15–9.
† Arch. Ital. Biol., ix. (1887) pp. 24–5.

(4) add 50 per cent. glycerin to the silver solution for very delicate results; to avoid surface precipitation cover the objects when removed from Müller's fluid with a sheath of paper brouillard previously prepared with distilled water. By following these methods Martinotti obtained most satisfactory results.

FREEBORN, G. C.—**Notices of New Methods. I.**
[1. Staining of elastic fibres (Lustgarten, Herxheimer, and Martinotti). 2. Substitutes for hæmatoxylin (Paneth and Francotte). 3. Mounting (Weigert).]
Amer. Mon. Micr. Journ., IX. (1888) pp. 26–7.

WILKINSON, W. H.—**Colour-Reaction: its use to the Microscopist and to the Biologist.** *Midl. Naturalist*, XI. (1888) pp. 1–4 (1 pl.).

ZIEMACKI, J.—**Zur Entfettung mikroskopischer Präparate von Eiter, Blut, Sputum u. s. w. vor der Tinction in wässe rigen Färbelösungen bei Untersuchung auf Mikro-organismen.** (On the removal of fat from microscopical preparations of pus, blood, sputum, &c., before using aqueous staining solutions in examinations for micro-organisms.) *St. Petersburger Med. Wochenschr.*, 1885, p. 130.

(5) Mounting, including Slides, Preservative Fluids, &c.

Indexing Microscopical Slides.*—Dr. R. H. Ward describes his system of indexing slides as developed in his "Slide-Catalogue."

"The alphabetical index is, of course, a large and essential portion of the system. Its pages are specially ruled for convenience in entering titles and numbers, and they have a capacity for several references to each slide, the volume for 2000 slides having room for about 10,000 references. Thus a leaf preparation may not unlikely be referred to under both popular and scientific names of the plant, and also under several such titles as, 'Leaf of ——,' 'Spiral vessels in ——,' 'Stomates of ——,' 'Raphides in ——,' &c. But as many simple slides require only two or three entries, the more complex ones will have room for eight or ten. The index is lettered alphabetically, the number of pages assigned to each letter depending upon the frequency with which that letter occurs at the beginning of English words. Subdivision is accomplished according to the vowel system of arrangement, whose advantages are familiar to all readers, and which may, by means of a few obvious expedients, be made applicable to slide-catalogues of various sizes. Thus the pages devoted to any letter, as *S*, are divided into six portions, and lettered *Sa*, *Se*, *Si*, *So*, *Su*, *Sy*; the first portion being for words beginning with *S*, and having *a* for their first vowel, and so on for the rest. Further subdivision depends so largely upon individual wants as to be best left optional with the user. But having given a page to the *Sa* words, for instance, it is hardly possible that any thoughtful person could throw all these together at random. Probably nearly every one would enter things pertaining to animals at the top of the page, vegetables in the middle, and minerals at the bottom, or *vice versâ*. A specialist in any department would give the lion's share of the page to his particular province, subdivided to suit himself; and the vegetable kingdom, being in the middle, could be carried up or down, where experience shows that room could best be spared. After such entries as starch, pollen, hair, &c., several lines would be left blank for similar items, so that ultimately these items would appear in blocks that would be instantly recognized on glancing at the page. In larger collections, where *Sa* included many

* The Microscope, vii. (1887) pp. 355–8.

pages, a certain number of these whole pages would be assigned to animal, vegetable, and mineral objects respectively. In this case a botanist, for instance, would probably reserve more pages for plants than for all the rest, and at first he might devote a column, or even a whole page, to such a group as starches, and a like portion of *Se* to seeds, one

Sa.—Animal.	No.
Saw-fish, tooth sec.	233
Scaly epithelium	272
Scale insect	2440-3, 2364
Scales (see Wings)	
„ Mosquito	273
„ Lepisma	2066
„ Podura	2797, 2090
„ Cabbage Butterfly	2106
„ Tinea	2699
„ Sole, and *in situ*	665-6
„ Trout	1596
„ Flounder, and *in situ*	1597-8
„ Gold-fish	1599
„ Eel	1863
„ Sturgeon, sec.	2096
„ Dog Shark	2098
Starfish (young)	2005
„ Madreporic body	2006
„ Pedicellaria	2007
„ Spine, secs.	2527-9, 2030-7
Sarcina	1495
Sarcoptes	1925-6
Scalp, secs.	2025-6
„ Negro	2131
Statoblasts of Cristatella	2508
Sarcoma, Giant-cell	573
„ Spindle-cell	1496
„ Cystic	1731
„ Osteo-	1792
„ Round-cell	2804
„ Melanotic	2987, 2820
Snails, "Palates"	1073-8

Vegetable.	No.
Scales (see Hairs)	
„ of Fern	207
"Star Polishing Powder"	2526
Starch, Corn	886
„ Potato, and *in situ*	887-8
„ Canna, pure and commercial	955-6
„ Wheat	980
„ Rice, pure and adulterated	1125-6
„ Arrowroot, and *in situ*	1699
Sanguinaria, sec.	710
"Star Fungus"	730
Salicine	1536, 855
Santonine	1029
Stamens (see Flowers)	
„ Lobelia	1367
„ Salvia	1368
„ Tradescantia	1710
„ Vaccinium	1839
„ Deutzia	1982
„ (Petaloid)	2880, 2173
„ Willow (to ovaries)	2740-4
Scalariform Vessels	2930, 2885
"Santa Monica" deposit	2891

Mineral.	
Satin Spar	589
Sand, Oolitic	987
„ Auriferous	2820
„ Sonorous	2907
Stalactite	2821, 1983
Slag from Iron Furnace	2256
„ Copper Furnace	2741

column of the seed page being given to whole seeds, and another to sections, &c. Subsequently, if too much space proved to have been reserved anywhere, the lower portion of the vacant parts would be filled with other things. By such expedients a rough but most useful working classification of the pages and their contents can be maintained until the book is nearly full. The accompanying sample page of *Sa* entries of

familiar objects, though much more crowded, and, therefore, less satisfactory than in actual use, shows how such a plan is carried out, and with what facility any object may be found in a collection of three or four thousand slides.

Obviously the catch-word by which an entry will be found is its first word, by which it was located and sought for: and the other most characteristic word, which distinguishes the item from others of its kind, and which may or may not be the only other word, may be underlined for easy recognition. The author uses pencils of different colours for this purpose, in the serial list as well as in the index—red for animal, green for vegetable, and blue for mineral specimens—and thus gains a perspicuity whose value is evident. By a little extra care in labelling the slides the same distinction of colour may be extended to the labels, using red, green, and blue tinted papers, or white paper with printed borders of those colours, as a means for rapidly recognizing and distributing the slides themselves whenever they have become mixed in use.

Though not admitting the absolutely alphabetical sequence attained by cards, this system is in some respects even more practical than that for small collections, say up to three or four thousand slides. It is easier to see and compare numerous items when collated upon a page than when stacked away in cards. Thus fifty or sixty entries of hairs or of crystals can be reviewed and compared, and a half-dozen selected for some purpose, much better by glancing over a page than by leafing over that number of separate cards; while the graphic effect of the page is of perceptible use in keeping one's mind constantly familiar with the extent and character of his collection. The cards are theoretically better, and in very large collections practically better, for finding any specified slide that one knows he wants; but are not better, nor even as good, for assisting him to decide what he wants among many."

COPLIN—**Brief Directions for Using the Microscopical Mounting Outfit (Jefferson design).** *Queen's Micr. Bulletin*, IV. (1887) pp. 45–6.

LATHAM, V. A.—**The Microscope and How to Use It.**
[XIII. Cements and useful recipes.] *Journ. of Micr.*, I. (1888) pp. 39–46.

(6) Miscellaneous.

Colouring matter of blood as a means for distinguishing between the gas exchange of plants in light and darkness.*—Dr. T. W. Engelmann, while experimenting as to the secretion of oxygen by purple bacteria, made use of hæmoglobin for showing the variations in the amount of oxygen developed under the influence of light by certain plants. For this purpose he placed a filament of *Spirogyra*, rich in chlorophyll, about 0·1 mm. thick and 1 cm. long, under a cover-glass, and immersed in a drop of defibrinated bullock's blood which had assumed the venous colour by transmitting a stream of hydrogen or carbonic acid through it. When the preparation was placed in diffused light, the immediate vicinity of the green filament for a distance of 1/2 to 1 or 2 mm. became bright red in ten to fifteen minutes. In direct sunlight the action was produced in a fraction of a minute. The boundary between the dark venous and the bright arterial colour was so sharp that under the Microscope it could be determined to less than 0·1 mm. In the dark the

* Arch. f. d. Gesammt. Physiol. (Pflüger), xlii. (1888) pp. 186–8.

venous colour returned in about the same time. By intense illumination of a single cell or part of a cell a bright-red area formed only about the illuminated spot.

The development of oxygen in the light and its absorption in the dark can be followed with a spectral ocular, or, better still, with the microspectral photometer. It is then seen that on illuminating the cell (gaslight or an electric incandescent suffices) in place of the dark absorption-bands of oxygenless hæmoglobin, the two dark bands of oxyhæmoglobin appear. The change becomes apparent in ten to twenty seconds, and first occurs at the surface of the cells, from which it spreads outwards. Per contra, in the dark the hæmoglobin-band returns.

The next step was to ascertain if the unequal effects of the different rays of the spectrum upon the development of oxygen could be rendered visible to the naked eye. For this purpose a filament of spirogyra was placed in venous blood under a cover-glass, and illuminated with a spectrum of about 1 cm. long from a Sugg's burner of 50 candle-power. In about fifteen minutes the boundary between the arterial and venous colour was seen in the extreme visible red, and it attained its maximum, about 1 mm., near C. Although, owing to the cloudiness of the weather, the experiments with sunlight were few, they were sufficient to show that the strongly refracting rays were more powerful than those of the gas spectrum. The maximum lay in the middle of the visible red, not in the orange or yellow. The action in the green between D and E was less strong than in the blue-green or blue. Even in the violet a slight action was perceptible. In conclusion, the author remarks that he does not doubt that plants with red, yellow, or brown chlorophyll will give characteristic "hæmatospectrograms" of the development of oxygen.

Microchemical Tests for Callus.*—Mr. F. W. Oliver gives the following microchemical tests for the callus which he finds in the trumpet-hyphæ and true sieve-tubes of *Macrocystis* and *Nereocystis*;† but they apply also to the callus in the sieve-tubes of Phanerogams.

(1) *Russow's callus reagent* (a mixture of equal parts of chlorzinc-iodine and iodine in potassic iodide) stains callus a deep brown; a very delicate test; (2) *Coralline-soda* (prepared by adding rosolic acid to a strong aqueous solution of sodium carbonate) gives a brilliant rose-pink; (3) *Bismarck brown* dissolved in water reveals a very decided stratification; (4) *Hoffmann's blue* (dissolved in 50 per cent. of alcohol) stains the callus-plates a brilliant blue; (5) *chlorzinc-iodine* does not, as a rule, stain the plates, but they swell up and show stratification; (6) *methylene-blue* gives negative results; (7) *hæmatoxylin*, with dilute solutions, the callus-plates stain deeply; (8) *hydric sulphate* causes the plates to swell up, showing a very beautiful stratification, and finally they are completely dissolved; (9) *potash* causes them to swell up, but does not actually dissolve them.

BEAUREGARD, H., and V. GALIPPE.—**Guide pratique pour les travaux de Micrographie, comprenant la Technique et les applications du Microscope à l'Histologie végétale et animale, à la Bactériologie, à la Clinique, à l'Hygiène et à la Médecine légale.** (Practical Guide to Microscopy, including technique and the application of the Microscope to vegetable and animal Histology, to Bacteriology, to Clinics, to Hygiene, and to Medical Jurisprudence.)
2nd ed., vii. and 901 pp., 586 figs., 8vo, Paris, 1888.

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* Ann. of Bot. i. (1887) pp. 109-11.

† See *ante*, p. 265.

BROWN, F. W.—**A Course in Animal Histology. I.**
Microscope, VIII. (1888) pp. 13–5.

GOLDMANN, F.—**Kritische Studien über die Bestimmungsmethoden des Stärkemehles in Vegetabilien, speciell in Körnerfrüchten.** (Critical studies on the methods of determining the presence of starch in plants, especially in grain-plants.)
24 pp., 8vo, Erlangen, 1887.

How to work with the Microscope. *Scientif. News*, I. (1888) p. 82.

JAMES, F. L.—**Clinical Microscopical Technology. X., XI. Examination of Semen.**
St. Louis Med. and Surg. Journ., LIII. (1887) pp. 357–60 (1 fig.); LIV. (1888) pp. 98–100.

[OSBORN, H. L.].—**Practical Courses.**
[Considers "microscopic investigation to be a subject that is far more important than microscopical technique."]
Amer. Mon. Micr. Journ., IX. (1888) p. 35.

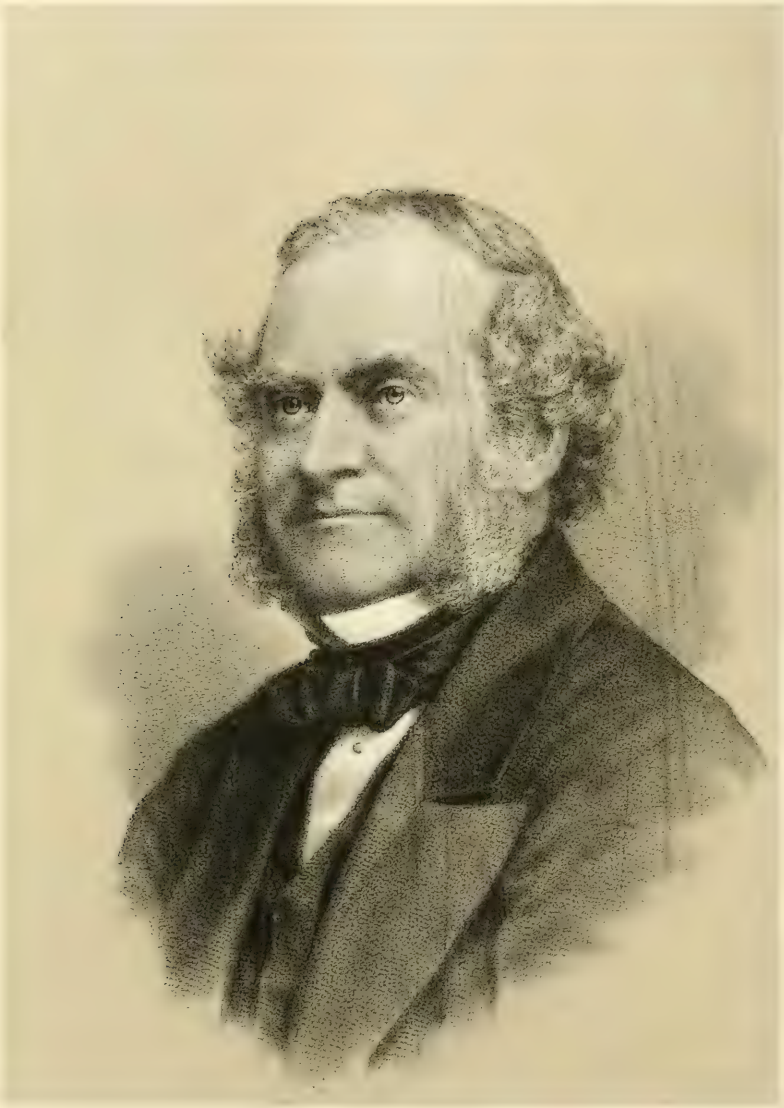
SMITH, T.—**The Microscope in the Study of Bacteriology.**
[Abstract of a paper read before the Microscopical Society of Washington, D.C.]
Amer. Mon. Micr. Journ., IX. (1888) pp. 34–6.

TATE, A. W.—**Use of the Microscope for practical purposes.** (The application of the Microscope to technological purposes.)
[Presidential Address to Liverpool Microscopical Society.]
Engl. Mech., XLVI. (1888) pp. 505–6; *Scientif. News*, I. (1888) pp. 116–7.

" " **Microscopical Examination of Commercial Fibres.**
[Brief abstract only.] 19th *Ann. Rep. Liverpool Micr. Soc.*, 1888, p. 13.

TAYLOR, T.—**Crystalline formations of Lard and other Fats.**
Microscope, VII. (1887) p. 358 (1 pl.).

WIESNER, J.—**Die mikroskopische Untersuchung des Papiers mit besonderer Berücksichtigung der ältesten orientalischen und europäischen Papiere.** (The microscopical investigation of paper, with special reference to the oldest Oriental and European papers.)
iii. and 82 pp., 1 pl. and figs., 4to, Wien, 1887.



JOHN MILLAR, L.R.C.P., F.L.S., F.R.M.S.

Died 1888.

PROCEEDINGS OF THE SOCIETY.

Annual Meeting of 8th Feb., 1888, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 11th January last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donor.

	From
Slides of *Chauliognathus Pennsylvanica*, *Doryphora decemlineata*, *Ectobia germanica* (2), and larva of Dragon-fly	*Mr. H. W. Fuller.*

The Report of the Council was read (see p. 330).

The adoption of the Report having been moved by Mr. Oxley, and seconded by Mr. McIntire, was carried unanimously.

Mr. Crisp said: While it has been usual for the President to be the official exponent of the Society's feelings on the occasion of the death of any prominent Fellow, I do not wholly regret that he has asked me to say a few words on Dr. Millar's death, not because the President in anything he might say on the subject would be formal or official only in any sense of the words, but because I am glad to have the privilege of testifying to our estimation of our deceased friend.

The good men that die are separated into somewhat different classes by the impressions which their deaths make upon us. There are the great and eminent men whose deaths we recognize as leaving the world distinctly the poorer thereby, and whom we cannot think of without sorrow, both for ourselves and our neighbours. This feeling is in every way genuine and sincere; but if analysed, there is a greater or less trace about it of what I may term a calculating nature; the sorrow and the regret is more particularly heightened by a sense of the *material* loss which has been sustained. If it is, for instance, a great party leader, or the prominent man of any other organization, we think of the results on the future of the organization. Our late friend was not to be placed with these, nor with that other class which includes those essentially good men whom we know never to have harmed a human being by word, or act, or thought, who have lived peaceable and peaceful lives, and the news of whose deaths we receive with feelings of genuine sorrow and regret; and yet with this there is added a large admixture of what I may almost call pity. To a different class to either of these belonged our late friend. Our sorrow and grief at his loss is an unqualified and unmixed feeling. We feel the loss, not so much for the world at large or for any of our fellow-men, but solely for ourselves, with the fullest intensity of purely personal feeling. What others have lost we do not stop or care to consider; we know that the world is the worse, but our sense of the loss we mourn is above and beyond any idea of measuring its extent. I do not wish to attempt to make any list of the qualities which endeared Dr. Millar to so many of us. I should be afraid that any such

attempt would leave much unrecorded, while if it embraced all that could be said it would inevitably be treated by some as dictated by what is sometimes called the "partiality of friendship." Moreover, I feel that a single sentence sums up that which best expresses what I mean. Dr. Millar was a typically genuine man. In all that he said or that he did, we knew that he was saying and doing exactly what he seemed to say and do;—that there was nothing behind, nothing to be read between the lines, nothing suggested by any selfish or personal motive or desire. Dr. Millar has been for more than thirty years a Fellow of this Society, and for nearly thirty years a member of the Council. Although he was a silent member, he was unremitting in his attendance at the meetings, and I can only recall two absences in the last ten years. His influence was largely felt, however, in all the affairs of the Society, and I personally am greatly indebted for the support which he gave me at times when a little encouragement was a very important matter and of very practical use.

Nothing shows more clearly the impression which Dr. Millar made upon those with whom he came into contact than the way they received the news of his death. It occurred on the day of one of the meetings of the Linnean Society, at which he was a constant attendant, and the expressions heard on all sides proved a depth and earnestness of pathetic feeling that is but rarely found—a feeling that is well recorded in the letter which I received from the President of that Society (Mr. Carruthers) on the day after the funeral, which, to my great sorrow, I was unable to attend: "Yesterday I stood by the open grave of one of the best friends and truest and most lovable men I have known—John Millar, aged 69."

I now beg to propose "that this Society desires to record the deep sorrow with which they have heard of the death of Dr. John Millar, so long a member of the Council, and who for more than thirty years has taken such a lively interest in the affairs of the Society, and that the secretaries be instructed to communicate this resolution to Dr. Millar's family."

Mr. Glaisher said that, as one of the oldest friends of Dr. Millar—one who knew him even before he came to London—he rose to second this resolution with great warmth of feeling. He agreed entirely with every word which Mr. Crisp had used in reference to the matter, and in which he had so well described what must indeed be felt by all to whom Dr. Millar had been intimately known.

The President felt sure that this resolution accorded so entirely with the feeling of the meeting, that he might declare it to be unanimously carried.

The list of Fellows proposed as Council and Officers for the ensuing year, as presented to the last meeting, was read as follows, the name of Prof. Chas. Stewart being substituted for that of Dr. Millar :—

President—*Charles T. Hudson, Esq., M.A., LL.D. (Cantab).

Vice-Presidents—Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.; *Rev. W. H. Dallinger, LL.D., F.R.S.; William Thomas Suffolk, Esq.; *Professor Charles Stewart, M.R.C.S., F.L.S.

Treasurer—Lionel S. Beale, Esq., M.B., F.R.C.P., F.R.S.

* Have not held during the preceding year the office for which they are nominated.

Secretaries—Frank Crisp, Esq., LL.B., B.A., V.P. & Treas. L.S.; Prof. F. Jeffrey Bell, M.A., F.Z.S.

Twelve other Members of Council—Joseph Beck, Esq., F.R.A.S.; *Alfred W. Bennett, Esq., M.A., B.Sc., F.L.S.; Rev. Edmund Carr, M.A.; Frank R. Cheshire, Esq., F.L.S.; Prof. Edgar M. Crookshank, M.B.; James Glaisher, Esq., F.R.S., F.R.A.S.; *Prof. J. William Groves, F.L.S.; *George C. Karop, Esq., M.R.C.S.; *John Mayall, Esq., Jun.; Albert D. Michael, Esq., F.L.S.; Prof. Urban Pritchard, M.D.; Charles Tyler, Esq., F.L.S.

The President having appointed Mr. Bevington and Mr. Dadswell to act as scrutineers, the ballot was proceeded with, and the Fellows nominated were declared by the President to be duly elected as Council and officers for the ensuing year.

The Treasurer's Account was, in the absence of Dr. Beale, read by Mr. Crisp (see p. 331), who moved that the account should be received and adopted, and that the thanks of the Society be given to the Treasurer for his services during the past year.

Mr. J. J. Vezey seconded the motion, remarking, as one of the Auditors, that they had found the accounts to be kept in a very satisfactory manner.

The President put the motion to the meeting, and declared it carried.

Mr. Crisp, in pursuance of the notice given at the preceding meeting, moved, "That the existing Bye-laws of the Society be repealed, and that the following be in future the Bye-laws of the Society." As the principal alterations and the reasons for making them had been fully explained at the previous meeting, and as a copy of the new Bye-laws had since been lying upon the table for the inspection of the Fellows, they were agreed to be taken as read.

The motion having been seconded by Mr. A. D. Michael, was put by the President, and carried unanimously.

Dr. Dallinger then delivered his annual address, which was listened to throughout with the deepest attention, and very heartily applauded by the large number of Fellows present.

Mr. Glaisher said that he rose with great pleasure—yet also with some pain—to ask the Fellows to give their warmest thanks to their late President, not only for the very admirable address to which they had just been listening, but also for the four years' service which he had so efficiently rendered to the Society. When they remembered that during the whole of that period he had been constantly with them at their meetings, although living at Sheffield, when they also remembered his regularity of attendance at their council meetings, his earnestness in all that affected the well-being of their Society and the interests of microscopical science, and when they coupled with all this the remembrance of what he had done when out of their presence, it needed nothing upon his (Mr. Glaisher's) part to convince them of the value of the services which their President had performed. They would part

* Have not held during the preceding year the office for which they are nominated.

from him with feelings of great regret, and would long preserve as a pleasant memory to look back upon the great enjoyment they had derived from the connection now about to be severed. For his own part, he could say that there was no time at which he had met him when he did not like him better than before. Residing as he did at all that distance from London, and yet attending to the duties of his office in the manner in which he had done during the whole of the four years he had presided over them, he was sure that the Fellows present would accord that vote of thanks with three times three. (Applause.) After that display of feeling, it was quite unnecessary to put the motion to the meeting in a more formal manner, as the appoval of it, which had been thus expressed, evidently came from the hearts of all. He trusted that the President would, on his part, be able to look back upon his period of office with as much pleasure as those who had been associated with him.

Prof. Bell said that after the way in which the Society had received the proposal, it was hardly necessary for him to add to what Mr. Glaisher had said. But after the very remarkable services rendered by Dr. Dallinger it was only right that one of those to whom the Society intrusted its business should express some sense of the thanks which were due to him as their outgoing President. If any one examined the conditions which appeared necessary to constitute a good President, they would be found summed up in the requirements that he must know everything of something and something of everything. In their own case the something to be known was not only the wide range comprised within the term "biological knowledge," but also what on the other side of the table was spoken of usually as brass and glass. When they began to look into the wide range of biological science they would find that it contained a very large number of subjects which were extremely interesting, yet if a person were to devote a lifetime to the study of the Volvocineæ or the Ostracoda, though he would undoubtedly be able to derive pleasure from the pursuit, it was more than possible that he would not be able to excite great interest in the subject amongst a large audience. But the subject of which the President knew everything was one which had been made interesting to all, and the questions which arose in connection with the processes of decomposition of organic matter were such as impressed them the most, and were the most widely interesting to instructed minds. If they considered what subjects the annual addresses of the President had brought before them, the importance of their range and of their bearing would be seen at once. In one of them he traced out the history of the formation of the cell-nucleus, whilst in another he described the long-continued and patient observations he had made as to the effects of change of environment under different degrees of temperature. These two subjects were treated by the President in a way such as no one but a thoroughly skilled microscopist would have been able to do. It might indeed be said that the President had offered an example in respect of careful and long-continued research which would go down, along with the labours of Darwin, as a striking example of what patience, perseverance, and love a true student of nature could throw into his work. Reference had also been made by Mr. Glaisher to the question of the President's attendance at the meetings, and though this was one which had to some extent naturally come under the notice of the Society, it was perhaps not so

much known that on leaving that room after the meetings he had generally gone back to Sheffield by the early newspaper train the next morning. If they wished to have a most obvious sign of his devotion to the interests of the Society, they could not find it better than in that fact. The last matter to which he would refer was the admirable manner and tact displayed by the President in conducting their meetings. Of this the Fellows themselves would be as good judges as he could be himself. He should like also to add that they must not conclude they were about to lose Dr. Dallinger; he would remain to them as one of their Vice-Presidents, and there was a rumour that a change in his environment was not improbable, which might result in the possibility of his being able to attend their meetings without having to undertake so long a journey.

Mr. Crisp said that it had fallen to him on all previous occasions to second the vote of thanks to Dr. Dallinger for his annual address; but he purposely did not do so on the present occasion lest it might look too stereotyped and formal; but on the other hand, if he did not say anything it might perhaps be thought that his enthusiasm had cooled down. What he had to say was summed up in a single remark which, however, required a preface. Carlyle had said that the people of England were, so many millions in number, "mostly fools." That, however, was not true, but only a piece of Carlylean exaggeration. If, however, he had said they were mostly humbugs, it would have been nearer the truth on account of the large number of people who said one thing and thought another. If he followed the ordinary practice he ought, no doubt, as an official of the Society, to affect to believe that the Society had shed great additional lustre upon Dr. Dallinger by allowing him for so long a time to be their President. If, however, they wished to admit the naked truth, it was that Dr. Dallinger had, during his Presidency, thrown great additional lustre upon the Society.

Dr. Dallinger said he felt it would be very improper on his part if he were to receive such warm expressions of cordial feeling without saying a few words in response. With regard to his attendance he might say that he had tried to make it a principle of his life, no matter what the subject might be, never to undertake what he did not mean to carry out thoroughly, so that it was with this intention that he had entered upon his duty as President. Of course, circumstances might sometimes arise beyond a person's control which would prevent him from doing all that he desired. This, happily, had not occurred in his case. He found the other day that his wife was commencing a calculation of the number of miles he had travelled in carrying out his engagement—a calculation which, however, he interrupted. He could, for his own part, say that it was a pleasure to him to look back upon the proceedings of these years, and he should always feel that the manner in which their thanks had been bestowed for such services as he had rendered constituted a deeper source of pleasure than he was able to express.

Mr. Crisp said that in his journeys to and fro to attend their meetings, the President had, he found, travelled a distance equal to more than half round the world.

Votes of thanks to the Auditors and Scrutineers for their services were proposed by Mr. A. D. Michael, seconded by Prof. J. W. Groves, and carried unanimously.

Mr. Crisp said he had received a letter from Dr. Hudson, the new President, expressing his regret at not being able to be present at the annual meeting, having met with an injury to his knee; he was, however, progressing favourably, and hoped to be present at their next meeting.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. Frank Ballard, M.A., Edward Halkyard, John Thompson, and Arthur J. Wolff, M.D.

REPORT OF THE COUNCIL FOR 1887.

Fellows.—43 Ordinary Fellows have been elected during the past year, whilst 29 have died, resigned, or been removed, leaving the increase during the year 14 Ordinary Fellows. One Honorary Fellow has been elected, Mr. P. H. Gosse, F.R.S. The list now stands as follows:—Ordinary Fellows 631, Honorary Fellows 50, Ex-officio Fellows 82, or in all—763.

The Society have to regret the deaths of several prominent Fellows since the commencement of the present year—three Honorary Fellows, Mr. G. R. Waterhouse, Prof. A. de Bary, and Dr. Asa Gray; and an Ordinary Fellow, Dr. John Millar. Dr. A. Farre, a Past President, died during the past year.

Mr. G. R. Waterhouse was for many years keeper of the Geological Department of the British Museum, and was the author of a Natural History of Marsupials and Rodents, a Catalogue of British Coleoptera, and a description of the Mammals collected during the voyage of the 'Beagle,' he being at the time Curator of the Zoological Society.

Dr. Anton de Bary, Professor of Botany at Strassburg, was well known as a distinguished Mycologist and as one of the most philosophical Botanists of the age. He may be said to have laid the foundation of our knowledge of Vegetable Pathology.

Dr. Asa Gray, who was elected an Honorary Fellow as long ago as 1851, was the most eminent of American botanists, and his influence with the late Mr. Darwin has recently been brought into prominent notice.

Dr. Arthur Farre, F.R.S., was the sixth President of the Society, having been elected in 1850, at which time he took a very active part in the affairs of the Society. He was afterwards appointed a Physician Extraordinary to the Queen and Physician Accoucheur to the Princess of Wales.

The Council cannot refer to the death of Dr. John Millar without expressing the deep sorrow with which they received the intelligence. Dr. Millar has been a Fellow of the Society for thirty-one years, and for twenty-eight years a member of the Council. At their last meeting the Council recorded their sense of the loss which they and the Society have sustained by his death, and a resolution on the subject will be submitted to the Annual Meeting.

Finances.—The net increase of revenue from the election of new Fellows during the past year has amounted to 34*l.* 2*s.* 6*d.* as against

THE TREASURER'S ACCOUNT FOR 1887.

Dr.

1887.	£	s.	d.
To Balance brought from 31st December, 1886	162	15	4
„ Interest on Investments	84	14	6
„ Admission Fees	79	16	0
„ Annual Subscriptions	778	4	6
„ Compositions	31	10	0
„ Journals sold by Assistant-Secretary	5	17	0
„ Reprints „ „	7	0	0
„ Sale of £98 2*s.* 3*d.* Consols	100	0	0
	£1249	17	4

Cr.

1887.	£	s.	d.
By Rent, Gas, and Attendance	96	4	0
„ Salaries, Reporting, and Commission	187	8	6
„ Books and Binding	132	15	0
„ Expenses of Journal	480	0	0
„ Reprints of ditto	5	16	0
„ Photographs of Presidents	33	12	0
„ Postage of Journal	39	18	6
„ Stationery and Miscellaneous Printing	8	15	0
„ Coffee at Evening Meetings	20	0	6
„ Fire Insurance	1	10	0
„ Petty Cash	41	3	1
„ Subscription to Mr. Bolton's Bottles	2	2	0
„ Marine Biological Association	100	0	0
„ King's College Hospital	1	1	0
„ Balance remaining 31st December, 1887	99	11	9
	£1249	17	4

L. S. Beale, *Treasurer.*

Investments, 31st December, 1887.

1200*l.* Freehold Mortgages. 861*l.* 10*s.* 3*d.* Three per cent. Consols (including 100*l.* Quekett Memorial Fund).

The foregoing Annual Account examined and found correct, 31st January, 1888.

J. J. Vezey
Walter W. Reeves } *Auditors.*

21*l.* 3*s.* in 1886. The invested funds of the Society stand at 2061*l.* 10*s.* 3*d.* (taking the Consols at par). The difference between this amount and that shown at the end of the previous year is occasioned by the sale of Consols to meet the donation of 100*l.* granted by the Society to the Marine Biological Association.

Library and Cabinet.—Considerable progress has been made with the rearrangement of the Library, and a number of books which were of no interest from a microscopical or biological point of view have been disposed of. It is intended to make a further revision with a view of excluding others for which there is no accommodation, and which can be only of secondary interest to the Fellows.

It has been found possible to add an additional shelf to some of the cases in the Library without interfering with their general construction.

The circulation of the books will commence at the beginning of the next Session under regulations which will be issued with the August number of the Journal.

Mr. Suffolk has continued his examination of the Cabinet, but the large number of the slides, and the defective state of many of them, require still more time to deal with satisfactorily.

Bye-Laws.—During the past year the Council have revised and amended the Bye-Laws, which had not been revised since their original issue at the time the charter was granted. Since that date some important modifications have been made, including the election of Ex-officio Fellows and the admission of Lady Fellows, and it became necessary to amend many of the provisions in order to make the Bye-Laws consistent throughout. Some new clauses have also been added, and as revised the Council think that the new Bye-Laws will be found to constitute a considerable improvement upon the old ones.

Journal.—The Council have much pleasure in indorsing the remarks made by Mr. Crisp in the preface to the last volume of the Journal with regard to the co-operation of the co-editors, and they cordially agree that the best thanks of the Society are due to these gentlemen for the able and persevering manner in which they have carried out the portions of the Summary of Current Researches committed to their charge.

MEETING OF 14TH MARCH, 1888, AT KING'S COLLEGE, STRAND, W.C., DR. R. BRAITHWAITE, F.L.S., VICE-PRESIDENT, IN THE CHAIR.

The Minutes of the meeting of 8th February last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Allen, T. F., The Characeæ of America. Part I., 62 pp., 54 figs. (8vo, New York, 1888)	*The Author.*
Martin, B., The Young Gentleman and Lady's Philosophy. 3 vols. (8vo, London, 1781–2)	*Executors of Dr. Millar.*

Mr. Crisp read a letter received from Dr. Hudson, the President, expressing the regret which he felt at his enforced absence in consequence of the effects of the accident to his knee, reported at the previous meeting.

Mr. Cooke exhibited a number of photomicrographs of the odontophores of Mollusca, as an attempt to illustrate this group of objects by photography. He said that the photographs had been made from specimens arranged and selected by his friend Mr. Watkins, his own part in the matter being the photography. Mr. Watkins had in his collection about 1400 specimens from which the series had been made. The classification of Mollusca by means of the radula dated back to the work of Prof. Lovén, but had not received the recognition which it should, and in his opinion would have in the future. He imagined that this want of attention was largely due to the extremely inadequate representations which had hitherto been made of these organs, for in the drawings usually made it had generally been the practice to select only one row of teeth, from which it was obvious that only a very imperfect idea could be obtained of the whole. The photographs had the advantage of showing considerably more. Then again the figures in most cases omitted the shading, which was a very important part, so that they failed to indicate the thickness. The present series of photographs had been prepared with a very rude apparatus, mainly of his own devising, which when closed folded into a space of 1 ft. 6 in., but could be expanded to 5 ft., thereby enabling him to get increased magnifying power without the necessity for using a large number of lenses. He had used Swift's 1 in., 1/2 in., and 1/4 in., and one of Zeiss's 1/12 in. immersion lenses with a projection eye-piece, giving for the whole a range of powers from 30 to 600. The results already obtained were such that he ventured to think that when that method of illustration became better known and had been further improved upon, the system of classification by the radula would receive better recognition. Amongst instances in which the application of the method had led to valuable results, he mentioned that there had been described as being found in Australia no less than fifty-two species of the genus *Physa* which ranged generally throughout the South Pacific. Specimens of these having come to hand, proved upon examination to be no *Physa* at all, but really a sinistral *Limnæa*, and when they were able to get more specimens, he thought it very likely that they would be able to get rid of the whole of those fifty-two species of so-called *Physa*. He ventured to ask any Fellows of the Society that could to assist them in procuring new specimens, as he found it a matter of extreme difficulty to obtain shells with the molluscs inside from the remote corners of the earth.

Prof. Stewart said that he had listened to the remarks of Mr. Cooke with very great pleasure, and was delighted with the series of photographs which had been submitted for their inspection, which he thought were exceedingly well done, considering that in many cases great difficulty was encountered in consequence of colour and want of flatness in the object. He should like to ask what was the bearing of the structure on the evidence as to the character of the food—was there anything which would tell them whether the creature was carnivorous or a vegetable feeder? and if the former, whether it fed upon the softer kinds of flesh, or was capable of boring through hard shell? In making a

collection so large as that of Mr. Watkins a great amount of experience in mounting must have been obtained, and he should therefore like to ask what kind of medium had been found best for the purpose. He had a number of slides of this kind, but his experience was like that of most other persons, that after a lapse of time a great many specimens became deteriorated: but he had some which were said to be mounted in "Suffolk"—whatever that might mean—and these were all in most excellent condition, both as to the way in which they were displayed and that in which they had retained their characters.

Mr. Cooke said, with regard to the character of the teeth as indicating the nature of the food, so far as the land mollusca were concerned there was a very marked distinction, the carnivora being conspicuous by having teeth with sharp arrow-like points; but in the case of slugs, which generally ate animal matter, but which would also eat anything else, and would even eat one another if other things failed, the radula presented a curious mixture of the sharp arrow-like forms with others of a squarer form approximating to that of the vegetable feeders. He could not say with certainty that the marine Mollusca fell into the same classification, because, more especially in the case of deep-sea varieties, it was difficult to say what their food really consisted of. As regarded mounting, all the preparations from which the photographs were taken were mounted in glycerin jelly.

Mr. Suffolk disclaimed all knowledge of the peculiar medium mentioned by Prof. Stewart; but as he had been advising for a number of years upon questions of mounting, it was just possible that it might be something which he had at some period recommended.

Mr. E. M. Nelson exhibited and described a new form of mechanical stage, in which two points were moved by milled heads in rectangular directions, carrying the slide with them, the slide being pressed against them when they were withdrawn by the hand.

Mr. Crisp said it seemed to him to be a very great disadvantage not to have the object follow the mechanical movements in both directions.

Mr. Michael said he should not like to have to use a stage on this principle, at any rate for the work in which he was chiefly engaged. He could not agree with what Mr. Nelson had stated as to the side movement being seldom wanted; for his own part he thought he used it more than he did the other.

Prof. Groves thought that one great disadvantage in the arrangement was that it necessitated the use of both hands to manipulate the slide, whereas the great advantage of the ordinary mechanical stage was that it left one hand free for focusing at the same time that the slide was being moved.

Mr. Crisp said that this, to his mind, was the fatal objection to Mr. Nelson's device, which really required three hands to work it properly.

Mr. C. L. Curties exhibited a new Combination Condenser, which in addition to the condenser also contained an iris diaphragm, a spot-lens, and a polarizing prism. It would, of course, like all "Combination" apparatus, be only used where portability was a desideratum.

Mr. Crisp exhibited Collins's Aquarium Microscope, which could be fixed by suction to the glass side of the tank, like the railway reading lamps. Also Klönne and Müller's Aquarium Microscope for examining objects in a small aquarium or trough, specially constructed for the purpose, and fitted with movable diaphragm slides. Also a new form of Thury's Quinque-ocular Class Microscope, having a reflecting prism made to rotate so as to exhibit the object upon the stage alternately to each of five observers. (See this Journal, 1887, p. 796.)

Mr. G. Massee read a paper "On the Type of a new Order of Fungi —Matuleæ," illustrating the subject by drawings on the board. (*Supra*, p. 173.)

Mr. G. Murray congratulated Mr. Massee on having recognized the features of this very interesting type. The Gasteromycetes were composed of a number of types which were linked together, but he should not have expected that those which Mr. Massee had mentioned were so closely related as he had shown them to be.

Mr. Bennett quite agreed with the last speaker that this was a very interesting paper. He had always considered that the Fungi must be regarded as a division of the vegetable kingdom quite distinct from the Algæ. Some years ago a method of classification was proposed which would have abolished the difference between them. This he always believed to be a mistake, and, therefore, though perhaps they could not regard fungi as a single series, it was encouraging to find one more proof of their connection *inter se*, rather than with the Algæ.

Mr. Rattray gave a *résumé* of his paper "A Monograph of the genus *Aulacodiscus*," the subject being illustrated by diagrams, and by a tabulated list of groups of allied species.

Mr. Carruthers, whilst afraid that the account which had been given by Mr. Rattray might not have been very attractive to the audience generally, yet felt sure that when they saw the paper printed *in extenso* they would find it very interesting to study. The table exhibited showed the result of a very great deal of work with regard to that very interesting group of diatoms. The genus was one which had long been known, and perhaps specimens of *Aulacodiscus formosus* were in the possession of every one interested in the subject. He wished that Mr. Rattray had been able to give them a demonstration of the central form and to explain the processes which went to form the distinctive type. No one could look at the table without seeing that it represented the result of a very careful examination of all the published information relating to those groups, and Mr. Rattray had been afforded opportunities of getting together the whole known material with relation to that genus. What he had done was to describe the whole in harmony, and when they came to read the paper they would find it to be a very exhaustive monograph of that interesting genus.

The Chairman said that Mr. Rattray had been setting them an example which he hoped would be largely followed, for he was quite sure that no better service could be done by any one than by working out the whole history of a separate group in the way it had been done

in this paper. There was a very large amount of work to be done in this way, and he considered that microscopists owed Mr. Rattray a debt of gratitude.

The Chairman announced that the date of the next Conversazione had been fixed for April 25th.

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—*Œcistes crystallinus.*

Mr. Cooke:—Photomicrographs of Odontophores of Molluscs.

Mr. Crisp:—(1) Collins's Aquarium Microscope; (2) Fol's Quinque-ocular Class Microscope; (3) Klönne and Müller's Aquarium Microscope and Tank.

Mr. C. L. Curties:—Combination Condenser, Iris Diaphragm, Spot-lens, and Polariscope.

Mr. Nelson:—Microscope with new mechanical stage.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. Edward Bage, Charles J. Martin, B.Sc., and Rev. George W. James, F.R.A.S.

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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One of the Secretaries of the Society
and a Vice-President and Treasurer of the Linnean Society of London;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

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AND

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FELLOWS OF THE SOCIETY.

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I.—APERTURE TABLE.

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	White Light. ($\lambda = 0{\cdot}5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\ \mu$, Line F.)	Photography. ($\lambda = 0{\cdot}4000\ \mu$, near Line *h*.)		
1·52	..	..	180° 0′	146,543	158,845	193,037	2·310	·658
1·51	..	..	166° 51′	145,579	157,800	191,767	2·280	·662
1·50	..	..	161° 23′	144,615	156,755	190,497	2·250	·667
1·49	..	..	157° 12′	143,651	155,710	189,227	2·220	·671
1·48	..	..	153° 39′	142,687	154,665	187,957	2·190	·676
1·47	..	..	150° 32′	141,723	153,620	186,687	2·161	·680
1·46	..	..	147° 42′	140,759	152,575	185,417	2·132	·685
1·45	..	..	145° 6′	139,795	151,530	184,147	2·103	·690
1·44	..	..	142° 39′	138,830	150,485	182,877	2·074	·694
1·43	..	..	140° 22′	137,866	149,440	181,607	2·045	·699
1·42	..	..	138° 12′	136,902	148,395	180,337	2·016	·704
1·41	..	..	136° 8′	135,938	147,350	179,067	1·988	·709
1·40	..	..	134° 10′	134,974	146,305	177,797	1·960	·714
1·39	..	..	132° 16′	134,010	145,260	176,527	1·932	·719
1·38	..	..	130° 26′	133,046	144,215	175,257	1·904	·725
1·37	..	..	128° 40′	132,082	143,170	173,987	1·877	·739
1·36	..	..	126° 58′	131,118	142,125	172,717	1·850	·735
1·35	..	..	125° 18′	130,154	141,080	171,447	1·823	·746
1·34	..	..	123° 40′	129,189	140,035	170,177	1·796	·741
1·33	..	180° 0′	122° 6′	128,225	138,989	168,907	1·769	·752
1·32	..	165° 56′	120° 33′	127,261	137,944	167,637	1·742	·758
1·31	..	160° 6′	119° 3′	126,297	136,899	166,367	1·716	·763
1·30	..	155° 38′	117° 35′	125,333	135,854	165,097	1·690	·769
1·29	..	151° 50′	116° 8′	124,369	134,809	163,827	1·664	·775
1·28	..	148° 42′	114° 44′	123,405	133,764	162,557	1·638	·781
1·27	..	145° 27′	113° 21′	122,441	132,719	161,287	1·613	·787
1·26	..	142° 39′	111° 59′	121,477	131,674	160,017	1·588	·794
1·25	..	140° 3′	110° 39′	120,513	130,629	158,747	1·563	·800
1·24	..	137° 36′	109° 20′	119,548	129,584	157,477	1·538	·806
1·23	..	135° 17′	108° 2′	118,584	128,539	156,207	1·513	·813
1·22	..	133° 4′	106° 45′	117,620	127,494	154,937	1·488	·820
1·21	..	130° 57′	105° 30′	116,656	126,449	153,668	1·464	·826
1·20	..	128° 55′	104° 15′	115,692	125,404	152,397	1·440	·833
1·19	..	126° 58′	103° 2′	114,728	124,359	151,128	1·416	·840
1·18	..	125° 3′	101° 50′	113,764	123,314	149,857	1·392	·847
1·17	..	123° 13′	100° 38′	112,799	122,269	148,588	1·369	·855
1·16	..	121° 26′	99° 29′	111,835	121,224	147,317	1·346	·862
1·15	..	119° 41′	98° 20′	110,872	120,179	146,048	1·323	·870
1·14	..	118° 0′	97° 11′	109,907	119,134	144,777	1·300	·877
1·13	..	116° 20′	96° 2′	108,943	118,089	143,508	1·277	·885
1·12	..	114° 44′	94° 55′	107,979	117,044	142,237	1·254	·893
1·11	..	113° 9′	93° 47′	107,015	115,999	140,968	1·232	·901
1·10	..	111° 36′	92° 43′	106,051	114,954	139,698	1·210	·909
1·09	..	110° 5′	91° 38′	105,087	113,909	138,428	1·188	·917
1·08	..	108° 36′	90° 34′	104,123	112,864	137,158	1·166	·926
1·07	..	107° 8′	89° 30′	103,159	111,819	135,888	1·145	·935
1·06	..	105° 42′	88° 27′	102,195	110,774	134,618	1·124	·943
1·05	..	104° 16′	87° 24′	101,231	109,729	133,348	1·103	·952
1·04	..	102° 53′	86° 21′	100,266	108,684	132,078	1·082	·962
1·03	..	101° 30′	85° 19′	99,302	107,639	130,808	1·061	·971
1·02	..	100° 10′	84° 18′	98,338	106,593	129,538	1·040	·980
1·01	..	98° 50′	83° 17′	97,374	105,548	128,268	1·020	·990
1·00	180° 0′	97° 31′	82° 17′	96,410	104,503	126,998	1·000	1·000
0·99	163° 48′	96° 12′	81° 17′	95,446	103,458	125,728	·980	1·010
0·98	157° 2′	94° 56′	80° 17′	94,482	102,413	124,458	·960	1·020
0·97	151° 52′	93° 40′	79° 18′	93,518	101,368	123,188	·941	1·031
0·96	147° 29′	92° 24′	78° 20′	92,554	100,323	121,918	·922	1·042
0·95	143° 36′	91° 10′	77° 22′	91,590	99,278	120,648	·903	1·053
0·94	140° 6′	89° 56′	76° 24′	90,625	98,233	119,378	·884	1·064
0·93	136° 52′	88° 44′	75° 27′	89,661	97,188	118,108	·865	1·075
0·92	133° 51′	87° 32′	74° 30′	88,697	96,143	116,838	·846	1 087
0·91	131° 0′	86° 20′	73° 33′	87,733	95,098	115,568	·828	1·099
0·90	128° 19′	85° 10′	72° 36′	86,769	94,053	114,298	·810	1·111
0·89	125° 45′	84° 0′	71° 40′	85,805	93,008	113,028	·792	1·124
0·88	123° 17′	82° 51′	70° 44′	84,841	91,963	111,758	·774	1·136

APERTURE TABLE—*continued.*

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	White Light. ($\lambda = 0{\cdot}5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\ \mu$, Line F.)	Photography. ($\lambda = 0{\cdot}4000\ \mu$, near Line *h*.)		
0·87	120° 55′	81° 42′	69° 49′	83,877	90,918	110,488	·757	1·149
0·86	118° 38′	80° 34′	68° 54′	82,913	89,873	109,218	·740	1·163
0·85	116° 25′	79° 37′	68° 0′	81,949	88,828	107,948	·723	1·176
0·84	114° 17′	78° 20′	67° 6′	80,984	87,783	106,678	·706	1·190
0·83	112° 12′	77° 14′	66° 12′	80,020	86,738	105,408	·689	1·205
0·82	110° 10′	76° 8′	65° 18′	79,056	85,693	104,138	·672	1·220
0·81	108° 10′	75° 3′	64° 24′	78,092	84,648	102,868	·656	1·235
0·80	106° 16′	73° 58′	63° 31′	77,128	83,603	101,598	·640	1·250
0·79	104° 22′	72° 53′	62° 38′	76,164	82,558	100,328	·624	1·266
0·78	102° 31′	71° 49′	61° 45′	75,200	81,513	99,058	·608	1·282
0·77	100° 42′	70° 45′	60° 52′	74,236	80,468	97,788	·593	1·299
0·76	98° 56′	69° 42′	60° 0′	73,272	79,423	96,518	·578	1·316
0·75	97° 11′	68° 40′	59° 8′	72,308	78,378	95,248	·563	1·333
0·74	95° 28′	67° 37′	58° 16′	71,343	77,333	93,979	·548	1·351
0·73	93° 46′	66° 34′	57° 24′	70,379	76,288	92,709	·533	1·370
0·72	92° 6′	65° 32′	56° 32′	69,415	75,242	91,439	·518	1·389
0·71	90° 28′	64° 32′	55° 41′	68,451	74,197	90,169	·504	1·408
0·70	88° 51′	63° 31′	54° 50′	67,487	73,152	88,899	·490	1·429
0·69	87° 16′	62° 30′	53° 59′	66,523	72,107	87,629	·476	1·449
0·68	85° 41′	61° 30′	53° 9′	65,559	71,062	86,359	·462	1·471
0·67	84° 8′	60° 30′	52° 18′	64,595	70,017	85,089	·449	1·493
0·66	82° 36′	59° 30′	51° 28′	63,631	68,972	83,819	·436	1·515
0·65	81° 6′	58° 30′	50° 38′	62,667	67,927	82,549	·423	1·538
0·64	79° 36′	57° 31′	49° 48′	61,702	66,882	81,279	·410	1·562
0·63	78° 6′	56° 32′	48° 58′	60,738	65,837	80,009	·397	1·587
0·62	76° 38′	55° 34′	48° 9′	59,774	64,792	78,739	·384	1·613
0·61	75° 10′	54° 36′	47° 19′	58,810	63,747	77,469	·372	1·639
0·60	73° 44′	53° 38′	46° 30′	57,846	62,702	76,199	·360	1·667
0·59	72° 18′	52° 40′	45° 40′	56,881	61,657	74,929	·348	1·695
0·58	70° 54′	51° 42′	44° 51′	55,918	60,612	73,659	·336	1·724
0·57	69° 30′	50° 45′	44° 2′	54,954	59,567	72,389	·325	1·754
0·56	68° 6′	49° 48′	43° 14′	53,990	58,522	71,119	·314	1·786
0·55	66° 44′	49° 51′	42° 25′	53,026	57,477	69,849	·303	1·818
0·54	65° 22′	47° 54′	41° 37′	52,061	56,432	68,579	·292	1·852
0·53	64° 0′	46° 58′	40° 48′	51,097	55,387	67,309	·281	1·887
0·52	62° 40′	46° 2′	40° 0′	50,133	54,342	66,039	·270	1·923
0·51	61° 20′	45° 6′	39° 12′	49,169	53,297	64,769	·260	1·961
0·50	60° 0′	44° 10′	38° 24′	48,205	52,252	63,499	·250	2·000
0·48	57° 22′	42° 18′	36° 49′	46,277	50,162	60,959	·230	2·083
0·46	54° 47′	40° 28′	35° 15′	44,349	48,072	58,419	·212	2·174
0·45	53° 30′	39° 33′	34° 27′	43,385	47,026	57,149	·203	2·222
0·44	52° 13′	38° 38′	33° 40′	42,420	45,981	55,879	·194	2·273
0·42	49° 40′	36° 49′	32° 5′	40,492	43,891	53,339	·176	2·381
0·40	47° 9′	35° 0′	30° 31′	38,564	41,801	50,799	·160	2·500
0·38	44° 40′	33° 12′	28° 57′	36,636	39,711	48,259	·144	2·632
0·36	42° 12′	31° 24′	27° 24′	34,708	37,621	45,719	·130	2·778
0·35	40° 58′	30° 30′	26° 38′	33,744	36,576	44,449	·123	2·857
0·34	39° 44′	29° 37′	25° 51′	32,779	35,531	43,179	·116	2·941
0·32	37° 20′	27° 51′	24° 18′	30,851	33,441	40,639	·102	3·125
0·30	34° 56′	26° 4′	22° 46′	28,923	31,351	38,099	·090	3·333
0·28	32° 32′	24° 18′	21° 14′	26,995	29,261	35,559	·078	3·571
0·26	30° 10′	22° 33′	19° 42′	25,067	27,171	33,019	·068	3·846
0·25	28° 58′	21° 40′	18° 56′	24,103	26,126	31,749	·063	4·000
0·24	27° 46′	20° 48′	18° 10′	23,138	25,081	30,479	·058	4·167
0·22	25° 26′	19° 2′	16° 38′	21,210	22,991	27,940	·048	4·545
0·20	23° 4′	17° 18′	15° 7′	19,282	20,901	25,400	·040	5·000
0·18	20° 44′	15° 34′	13° 36′	17,354	18,811	22,860	·032	5·555
0·16	18° 24′	13° 50′	12° 5′	15,426	16,721	20,320	·026	6·250
0·15	17° 14′	12° 58′	11° 19′	14,462	15,676	19,050	·023	6·667
0·14	16° 5′	12° 6′	10° 34′	13,498	14,630	17,780	·020	7·143
0·12	13° 47′	10° 22′	9° 4′	11,570	12,540	15,240	·014	8·333
0·10	11° 29′	8° 38′	7° 34′	9,641	10,450	12,700	·010	10·000
0·08	9° 11′	6° 54′	6° 3′	7,713	8,360	10,160	·006	12·500
0·06	6° 53′	5° 10′	4° 32′	5,785	6,270	7,620	·004	16·667
0·05	5° 44′	4° 18′	3° 46′	4,821	5,225	6,350	·003	20·000

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104	2 inches	17	2 10 0					
105	1½ inch	23	2 10 0	30	48	90	120	150
106	⅔ inch	25	2 0 0	70	112	210	280	350
107	⅔ inch	32	2 10 0					
108	½ inch	45	2 10 0	100	160	300	400	500
109	$\frac{4}{10}$ inch	65	4 0 0	125	200	375	500	625
110	$\frac{4}{10}$ inch	95	5 0 0	150	240	450	600	750
111	¼ inch	75	3 10 0	200	320	600	800	1000
112	⅕ inch	120	4 10 0	250	400	750	1000	1250
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153	½ inch	38	1 5 0	90	116	205
154	¼ inch	80	1 5 0	170	220	415
155	$\frac{1}{10}$ inch	110	2 5 0	250	330	630
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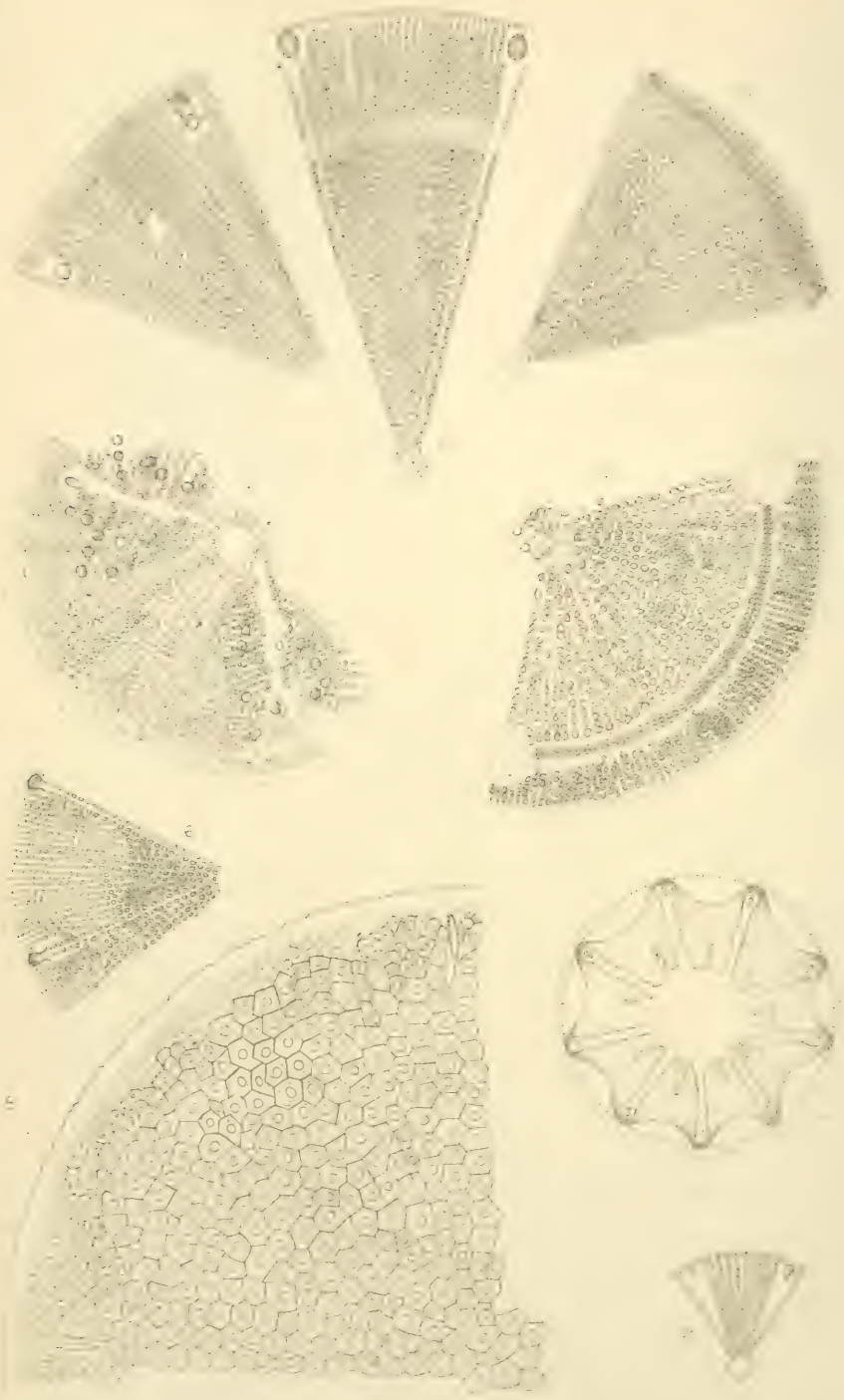
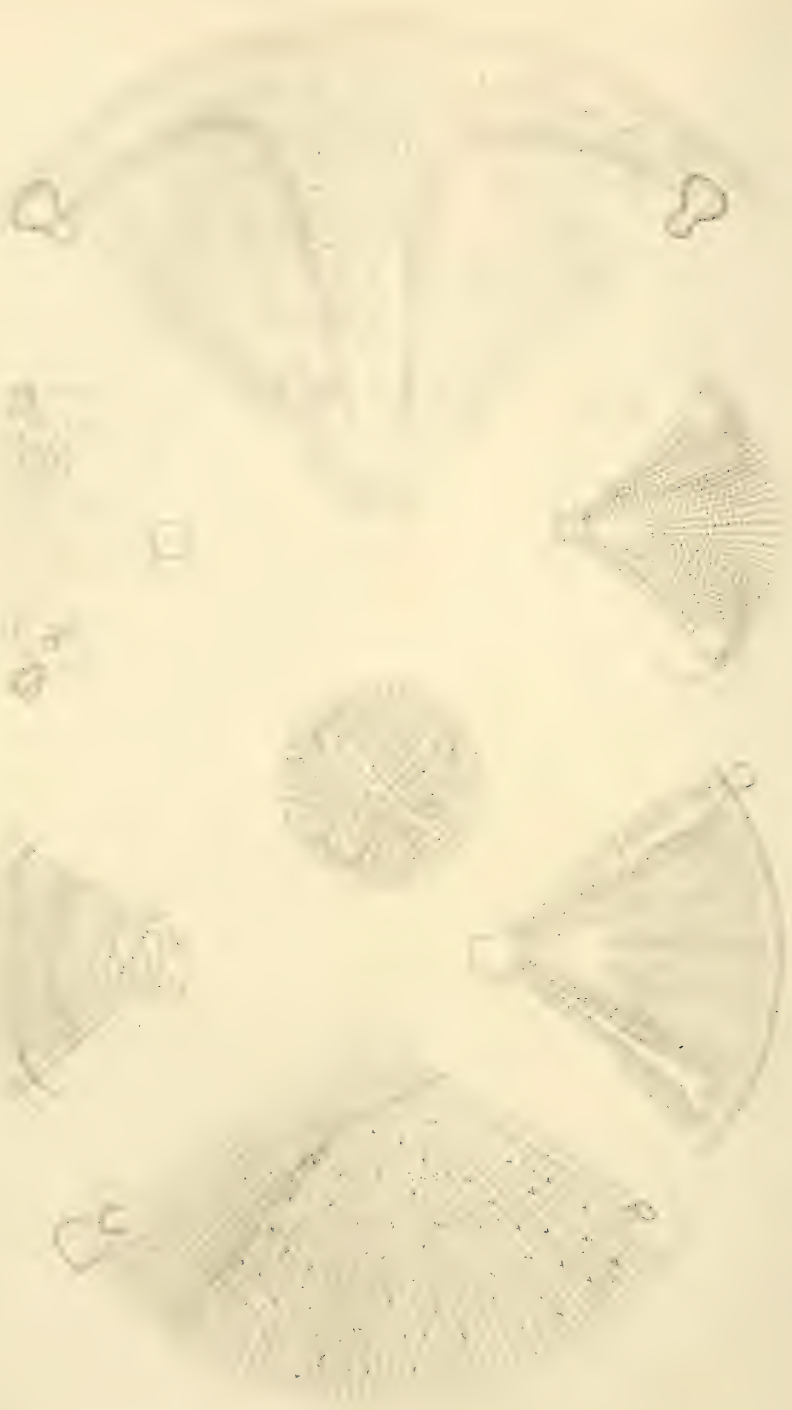
Aulacodiscus.



West, Newman & Co. lith.

Aulacodiscus.



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Aulacodiscus.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE 1888.

TRANSACTIONS OF THE SOCIETY.

VI.—*A Revision of the Genus Aulacodiscus Ehrb.*

By John Rattray, M.A., B.Sc., F.R.S.E.

(*Read 14th March*, 1888.)

Plates V., VI., and VII.

In the preparation of the following monograph I have examined the extensive series of specimens in the British Museum, Natural History, which are included in the collections of Greville, Dickie, W. Smith,

EXPLANATION OF PLATES V., VI., AND VII.

Plate V.

Fig. 1.—Aulacodiscus gracilis sp. n. × 660.
„ 2.—A. attenuatus sp. n. × 460.
„ 3.—A. lucidus sp. n. × 460.
„ 4.—A. concinnus Kitton MS. × 660.
„ 5.—A. prominens Kitton MS. × 660.
„ 6.—A. intumescens sp. n. × 460.
„ 7.—A. carruthersianus Kitton and Grove MS. × 460.
„ 8.—A. compactus sp. n. × 460.
„ 9.—A. dispersus sp. n. × 660.
„ 10.—A. rotulus sp. n. × 460.

Plate VI.

„ 1.—A. neglectus sp. n. × 460.
„ 2.—A. patens sp. n. × 460.
„ 3.—A. margaritaceus var. inconspicua nov. × 460.
„ 4.—A. excavatus var. apiculata nov. × 660.
„ 5.—A. Comberi var. irregularis nov. × 660.
„ 6.—A. decorus var. canariensis nov. × 460.
„ 7.—A. exiguus var. undulata nov. × 660.
„ 8.—A. crux var. subsquamosa Grun. MS. × 660.
„ 9.—A. umbonatus var. dirupta Grove and Sturt MS. × 660.

Plate VII.

„ 1.—A. Petersii var. expansa nov. × 660.
„ 2.—A. Petersii var. rara nov. × 660.
„ 3.—A. inflatus var. stellata nov. × 660.
„ 4.—A. inflatus var. minor nov. × 660.
„ 5.—A. amœnus var. subdecora nov. × 660.
„ 6.—A. spectabilis var. depressa nov. × 660.
„ 7.—A. Comberi Arnott × 660. Showing the inner apiculate layer of the valve.

Note.—As the new species *A. parvulus* mihi, *A. acutus* mihi, and *A. coronatus* Grove MS. came to my knowledge only after the plates were in proof, it has not been possible to give figures of them.—J. R.

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coronatus Grove .. .. „

and O'Meara, Hauck and Richter's 'Phykotheka Universalis,' and H. L. Smith's 'Diatomaceæ Species Typicæ,' and have through the great kindness of Mr. E. Grove, Dr. James Rae, Dr. John Murray, Mr. Julien Deby, Mr. Laurence Hardman, Mr. Kitton, Mr. William A. Firth, Mr. Doeg, Dr. Griffin, Dr. Gray, Herr E. Weissflog, Dr. Otto N. Witt, Dr. Pantocsek, and Herr Kinker, been able to examine the specimens from their private collections. Prof. Wittrock has also kindly forwarded to me the preparations belonging to Prof. P. T. Cleve, preserved in the Royal Botanical Museum, Stockholm.

Aulacodiscus Ehrb. emend., Ehrb. Mon. Ber. Ak., 1844, p. 73.—Valve circular, rarely polygonal. Surface flat, crateriform, or with a raised zone; inflations small and mammillate beneath processes, or large and cuneate along primary rays, sometimes absent. Colour transparent, grey or lurid. Central space irregular or round, hyaline or punctate, filled in by a rosette, or absent. Markings round, oval, or angular, sometimes pearly, in rows straight or slightly curved, radial or parallel within the compartments, and forming secondary oblique or concentric lines; interspaces hyaline or punctate. Primary rays distinct, rarely inconspicuous, on a level with or raised above adjoining area, the rows diverging, rarely in contact. Border with radial or oblique, rarely moniliform striæ, sometimes hyaline, usually distinct. Processes 1 to 45, inserted near border, conspicuous or small, sometimes absent.—*Tripodiscus* Ehrb. Abh. Ber. Ak., 1839, p. 159; *Tetrapodiscus* Ehrb. Mon. Ber. Ak., 1843, p. 166; *Pentapodiscus* Ehrb., ibid.; *Podiscus* Bail. Amer. Journ. Sci., 1844, vol. xlvi. p. 137; *Eupodiscus* Ehrb. *pro parte*, Mon. Ber. Ak., 1844, p. 73.

§ 1. Complanati.

Surface flat to 1/3 of radius or onwards to processes. Markings in radial straight rows. Primary rays not elevated.

A. suspectus Sch., Atl., pl. xxxvi. figs. 17, 18.—Diam. 0·05 to 0·075 mm. Surface flat almost to border. Colour dark brown on median zone, and light brownish-grey near border. Central space irregularly angular, 1/12 to 1/15 of diam. broad, hyaline. Markings rounded, granular, 6 in 0·01 mm., decreasing regularly outwards, towards central space their faint outlines visible. Primary rays 3 or 4, indistinct, straight, extending for 1/7 to 1/10 of radius from circumference, the rows closely apposed. Border indistinct, nonstriated. Processes absent, no clear area at outer ends of primary rays.

Allied to *Coscinodiscus*. Möller, according to Schmidt, makes this a var. of *Coscinodiscus punctulatus* Ehrb. Cleve's specimens are certainly without processes, and Schmidt figures the valve with no indication of their scars, though in his text he incorrectly says that these scars exist. Processes are also absent from *A. apedicellatus* sp. n. and abnormal forms of *A. Kittoni*.

Habitat: Mors deposit, Jutland (Schmidt, Cleve!).

A. Beeverix Johnson, in Pritch. Inf., p. 844, pl. vi. fig. 5.—Diam. 0·0625 to 0·08 mm. Surface flat to zone of processes. Colour steel grey at centre, smoky grey towards border. Central space irregularly rounded, 1/16 to 1/17 of diam. broad, closely punctate. Markings round or bluntly angular, 4 in 0·01 mm., central dot dark, interspaces irregular, small, punctate. Primary rays with markings round or compressed when in contact, the space between the rows evident, expanding gently outwards. Border striæ 8 to 10 in 0·01 mm., 1/25 to 1/32 of radius broad, mostly in contact with outer ends of rows of markings. Processes 3, insertion about 1/5 of radius from circumference, no space at base.—Sch. Atl., pl. xxxvi. fig. 12; Cleve, Diats. Vega Exp., p. 509.

Johnson's type in Greville's collection is somewhat imperfect, the processes being broken off, leaving a roundly elliptical scar.

Habitat: New Zealand (Johnson!); Sydney (Cleve).

Var. *ceylanica*. *A. Comberi* var. *ceylanica* Grun., Cleve & Möller's Diat., No. 278.—Diam. 0·06 mm. Central space less distinctly punctate. Markings smaller, 6 in 0·01 mm. Primary rays less obvious, the rows diverging less towards processes.

Habitat: Ceylon (Grove!).

A. simplex sp. n.—Sp. aff. *A. decoro* Grev., Sch. Atl., pl. xxxiii. fig. 9.—Diam. 0·1275 mm. Surface flat for 1/3 to 1/2 of radius. Colour pale grey at centre, light bluish on median zone, pale grey towards border. Central space obtusely angular, about 1/3 of diam. broad, hyaline, boundary faint. Markings rounded granules, 4 to 5 in 0·01 mm., with narrow, clear interspaces, arranged in secondary irregular concentric bands, and less crowded towards central space. Primary rays inconspicuous, rows diverging but slightly outwards, interspace hyaline. Border striæ 10 in 0·01 mm., 1/31 to 1/32 of radius broad, separated from radial rows by an irregular clear space about 1/53 of radius broad. Processes 6, symmetrical, insertion about 1/5 of radius from circumference, proximal portion rounded, distal more cylindrical, constriction median, sharp but shallow, free ends rounded, length about $3\frac{1}{3}$ times breadth, clear space at base small.

More nearly allied to *A. probabilis* and *A. Comberi* than to *A. decorus*. Scar of broken-off process is obovate.

Habitat: Monterey (Weissflog!).

A. probabilis Sch., Atl., pl. xxxvi. figs. 13, 14, excl. 15, 16.—Diam. from 0·045 to 0·105 mm. Surface flat to about half-way to processes, within the border almost flat for about 1/10 of radius. Colour pale grey, darker towards processes, sometimes light blue at centre. Central space circular, elliptical, or irregular, 1/16 to 1/21 of diam. broad, finely punctate, a limiting band of markings rarely distinct. Markings rounded near centre, 4 in 0·01 mm., moniliform near border, central dot minute; interspaces on inner half narrow, irregular, punctate; the rows sometimes deflected near processes, only distinct beyond middle of radius. Primary rays distinct only near processes. Border striæ

12 in 0·01 mm., 1/15 to 1/21 of radius broad, indistinct. Processes 2 to 4, insertion 1/3 to 2/7 of radius from circumference, proximal portion equal to distal, constriction median, wide, shallow, free ends rounded, length about 5 times breadth, no space at their base.—Sch. Atl., pl. civ. figs. 3, 4.

The central space is larger as the number of processes is less. Some valves from Simbirsk have the free ends of the processes more knob-like than others. Transitional to the simpler species of the section Radiati.

Habitat: Simbirsk Polirschiefer (Weissflog! Rae!); Monterey stone (Cleve! Weissflog!); Barbadoes (Firth!); Sysran deposit, Siberia (Hardman!).

A. parvulus sp. n.—Diam. 0·0675 mm. Surface flat to zone of processes, slope to border gentle. Colour smoky grey, lighter towards border. Central space rounded, about 1/27 of diam. broad, hyaline. Markings polygonal, 6 in 0·01 mm., decreasing but slightly towards border, without interspaces. Primary rays inconspicuous, rows in contact to their outer ends. Border hyaline, inner edge distinct, about 1/18 of radius broad. Processes 5, symmetrical, insertion about 1/4 of radius from circumference, large, constriction median, shallow, free ends rounded.

Habitat: Shell cleanings Nicobar Islands (Doeg!).

A. Browneii Norman, in Pritch. Inf., p. 844.—Diam. 0·06 to 0·0775 mm. Surface flat to zone of processes. Colour pale blue or grey, light or dark grey at border. Central space irregular, 1/24 to 1/36 of diam. broad, hyaline, rarely reduced to an elongated clear line. Markings rounded, towards centre more irregular, 5 in 0·01 mm., rows sometimes slightly bent, at outer ends separated by narrow clear spaces, secondary concentric bands obvious, sometimes confined to elevated central portion or to periphery. Primary rays distinct, space between rows narrow as on rest of surface. Border striæ 12 to 14 in 0·01 mm., 1/30 to 1/36 of radius broad, sometimes a narrow clear band at its inner edge. Processes 2 to 4, insertion 1/3 to 2/9 of radius from circumference, proximal portion oval, with a rounded, faint, obliquely placed mark on the corresponding side of all the processes of same valve, distal larger spathulate, clear space at base small. —Sch. Atl., pl. xxxvi. figs. 15–16; pl. cv. fig. 6.

In specimens with 2 processes the concentric bands are most obvious at periphery. In the presence of a faint oblique mark at base of processes this species recalls *A. barbadensis*. It is allied to the flatter forms of *A. kilkellyanus*.

Habitat: Monterey stone (Greville! Hardman! Stokes! Arnott!); Santa Monica deposit (Rae!); marine algæ, California (Rae!); shell scrapings, California (Grove!); on *Haliotis* shell, South Sea Islands (Hardman! Weissflog!).

A. Comberi Arnott, in Pritch. Inf., p. 844.—Diam. 0·11 to 0·265 mm. Surface flat to processes, rarely depressed at centre for 1/4 to 1/5 of radius. Colour lurid or pale to brownish grey around

centre, rarely hyaline. Central space rounded or 3–4-angled, about 1/21 of diam. broad, punctate. Markings rounded or angular, 3 to 3½ in 0·01 mm.; interspaces most obvious towards centre, narrow, irregular, and punctate; rows moniliform towards border, rarely subfasciculate, secondary rows irregular, oblique, or subconcentric towards centre. Primary rays distinct, between the rows a narrow wavy space. Border striæ 10 in 0·01 mm., 1/28 to 1/55 of radius broad. Processes 3 to 5, insertion 1/4 to 1/11 of radius from circumference, large but faint, proximal portion smaller than distal, free ends flattened, angles rounded, inner end of axial structure distinct, obovate, space at base distinct, punctate.—Pl. VII. fig. 7; Sch. Atl., pl. xxxvi. fig. 11; pl. civ. fig. 5. *A. Habirshawii* Pant., Fossil. Bacil. Ung., p. 58, pl. xxix. fig. 296; *A. Mulleri* Grun., Sch. Atl., pl. xli. fig. 11.

The inner layer of the valve is sometimes minutely apiculate. On corresponding side of base of each process there occurs a faint oval mark, only visible when the valve is transparent, as in *A. Browneii* and *A. barbadensis*. The scar of the broken-off process is roundly elliptical. Schmidt distinguishes *A. Mülleri* by its being quite flat, but this seems scarcely sufficient to found another species.

Habitat: Peruvian guano (Rae! Hardman! Macrae! Weissflog!); Bolivian guano (Kinker!); Pabillan de Pico guano (Kinker! Cleve!); Ichaboe guano (O'Meara!); "guano" (Norman! Macrae!); San Filipe guano (Ralfs).

Var. *irregularis*.—Diam. 0·1075 mm., a faint depression opposite each process. Surface flat at centre. Colour pale lurid grey, border darker. Markings in zones, from centre to semi-radius rounded, at semi-radius on a band 1/7 to 1/8 of radius broad, angular, from this to processes rounded, between processes on a narrower band 1/21 to 1/24 of radius broad, and separated from inner and outer portions by granulate narrow areas, again angular. Primary rays with markings in rows similar to those on corresponding areas of compartments. Border striæ 7 to 8 in 0·01 mm., 1/23 to 1/24 of radius broad. Processes 3, insertion about 2/11 of radius from circumference.—Pl. VI. fig. 5.

Habitat: Pabillan de Pico guano (Weissflog!).

A. hyalinus Pant., Fossil. Bacil. Ung., p. 58, pl. i. fig. 5.—Diam. 0·25 mm. Surface, central portion flat to processes with outer edge indistinct and concave between these, slope to border gentle. Colour light grey, darker towards border. Central space quadrate, about 1/25 of diam. broad, delicately punctate. Markings round, small, outlines faint, central dot distinct, interspaces unequal, large, punctate; sub-equal to zone of processes, near border moniliform; rows straight radial, secondary rows irregular, oblique towards centre, straight between processes. Primary rays undifferentiated towards centre. Border striæ faint, 8 to 10 in 0·01 mm., inner edge definite, about 1/50 of radius broad. Processes 9, insertion about 1/8 to 1/10 of radius from circumference, clear space at base non-punctate, almost semicircular, with the greater convexity towards the centre.

The scar of the broken process is irregularly obovate. Allied to *A. Comberi.*

Habitat: Szent Peter deposit (Pantocsek!)

A. minutus sp. n. *Cestodiscus* or *Aulacodiscus?* Sch. Atl., pl. lviii. fig. 34.—Diam. about 0·025 mm. Surface flat to zone of processes, slope to border gentle. Colour pale grey (?) Central space absent. Markings rounded granular, irregular at centre, in subradial rows to processes. Interspaces hyaline. Primary rays distinct, rows separated by a wide interspace of uniform breadth. Border striæ distinct, 8 in 0·01 mm., about 1/9 of radius broad. Processes 14, insertion about 1/9 of radius from circumference, consisting of a single portion with rounded ends.

Habitat: Monterey (Weissflog).

§ 2. Tenerrimi.

Surface flat. Central space hyaline or with faint grey tinge. Primary rays distinct. Border hyaline. Processes minute.

A. exiguus Witt., Simb. Polirsch., p. 19, pl. viii. fig. 6.—Diam. 0·03 mm. Colour almost hyaline, the areas about primary rays a little darker. Central space round, about 1/6 of diam. broad, tinged light grey, outside of this a clear narrow band with a short conical clear space extending into middle of apex of each compartment for about 1/6 of radius, and forming a distinct stellate figure. Markings unresolved. Primary rays with the rows undifferentiated, the interspaces surrounding at peripheral ends the bases of processes. Processes 5, subsymmetrical, insertion about 1/4 of radius from circumference as minute radially elongate narrow marks.—Sch. Atl., pl. ci. fig. 12.

Habitat: Simbirsk Polirschiefer (Weissflog!).

Var. *undulata.*—Diam. 0·06 mm. Central area about 1/5 of diam. broad, a broader clear line passing from it into apex of each compartment, with edges more irregular. Markings larger, as close minute puncta, most evident at edge of primary rays, outer edge of sculptured area undulate, with sides convex at processes and concave on compartments. Primary rays 9, symmetrical, insertion about 1/12 of radius from circumference. Border with a single band of minute puncta, within it a clear area, widest at middle of compartments.—Pl. VI. fig. 7.

Habitat: Oamaru deposit (Hanwell!).

A. barbadensis Ralfs, in Pritch. Inf., p. 939.—Diam. 0·045 to 0·0825 mm. Colour pale smoky grey. Central space round to 4-angled, 1/12 to 1/17 of diam. broad, edges uneven, with sides at right angles to directions of primary rays. Markings polygonal, 12 in 0·01 mm., without interspaces, less regular near central space, rows radial, secondary rows irregularly concentric towards centre, minute apiculi sometimes present, except on an area at middle of each compartment in zone of processes similar to the clear area at base of processes on same valve. Primary rays with indistinct rows. Border

1/12 to 1/16 of radius broad, well marked. Processes 3 or 4, insertion 1/3 to 1/6 of radius from circumference, minute, constriction shallow, a faint ovate oblique mark towards same side of base of each, clear area at base irregularly semicircular or triangular, its edge delicately striated at right angles to its margin.—*A. notatus* Grove & Sturt, Journ. Quek. Mic. Cl., 1887, pp. 9, 146, pl. iii. fig. 11.

Habitat: Newcastle deposit, Barbadoes (Rae! Firth!); Oamaru deposit, New Zealand (Grove & Sturt!).

§ 3. Radiati.

Surface crateriform or almost flat at centre, highest zone distinct, often convex and angular at primary rays, which are usually elevated. Clear space at base of processes minute.

A. kilkellyanus Grev., Trans. Mic. Soc. Lond., 1863, p. 70, pl. iv. fig. 14.—Diam. 0·075 to 0·1025 mm. Surface rising for almost 1/3, or flat for 5/9, of radius, outside of highest zone plain or slightly sigmoid—first concave then convex between processes; no inflations; slope to border gentle. Colour pale grey, darker at border. Central space rounded, 1/17 to 1/20 of diam. broad, hyaline, boundary faint. Markings round, 4 in 0·01 mm, decreasing uniformly to border, outlines faint, central dot distinct, interspaces minute, hyaline, rows straight, radial, the shorter attenuating inwards. Primary rays inconspicuous, rows in contact or with a narrow interspace not expanding outwards. Border striæ 12 to 14 in 0·01 mm., about 1/40 of radius broad, inner edge distinct. Processes 3 or 4, insertion 1/4 to 1/5 of radius from circumference, hourglass-shaped, proximal and distal portions equal, constrictions deep, length about 2½ times breadth, clear space at base distinct.

Habitat: Cambridge deposit, Barbadoes (Greville! Johnson! Hardman!).

Var. *minor*.—Diam. 0·0525 mm. Surface forming a low cone, convex from centre to about 1/3 of radius. Central space angular, about 1/21 of diam. broad. Markings subequal, 8 in 0·01 mm., rows separated by narrow clear lines. Primary rays more distinct, traceable to central space. Striated border absent. Processes? insertion about 2/7 of radius from circumference.

Dr. Greville had distinguished this as a species, but on what appears to me insufficient grounds. The scar of the broken-off process is elliptical.

Habitat: Bridgewater, Barbadoes (Johnson!).

Var. *sparsa*. *A. sparsus* Grev., Trans. Mic. Soc. Lond., 1866, p. 123, pl. xi. fig. 6.—Diam. 0·075 mm. Surface most elevated at centre, slightly convex to processes, slope to border steep. Central space bluntly and irregularly 4-angled, about 1/20 of diam. broad. Markings sometimes polygonal and in contact, decreasing but slightly towards border, and little more crowded here than on other parts of valve. Primary rays only recognized on central half when traced inwards

from processes. Border striæ 8 to 10 in 0·01 mm., about 1/20 of radius broad. Processes 3 or 4, insertion about 1/5 of radius from circumference, cylindrical, attenuating towards base, free ends emarginate.

Habitat: Barbadoes deposit (Greville!).

The Ceylon specimen from Witt, figured by Schmidt (Atl. pl. cii. fig. 3), appears to me to be nearer to var. *sparsa* from its markings, primary rays, and processes, but its surface is very convex.

A. decorus Grev., Trans. Mic. Soc. Lond., 1864, p. 82, pl. x. fig. 2. —Diam. 0·1025 to 0·13 mm. Surface flat to about semi-radius, or slightly depressed at central space, with outer edge distinct and concave, outermost 1/3 of compartments almost flat. Colour pale bluish at centre, elsewhere grey, darker towards border. Central space irregularly rounded, 1/20 to 1/21 of diam. broad, hyaline. Markings angular, 5½ to 6 in 0·01 mm., outlines faint, near processes oval, oblique, rows subradial, converging round processes, concentric near centre, interspaces most evident at origin of shorter rows. Primary rays with rows diverging slightly outwards. Border striæ 12 to 14 in 0·01 mm., about 1/27 of radius broad, inner edge sharp. Processes 6, insertion about 1/5 of radius from circumference, proximal portion rounded, distal subcylindrical, free ends truncate, length 1½ to 2 times breadth.—Sch. Atl., pl. cv. fig. 8.

The scar of the broken-off process is oval.

This species is sometimes confounded with *A. amœnus*, but bears to it but little affinity. *A. Stoschii*, figured by Walker and Chase, is distinct. A Panama specimen in the Royal Botanical Museum, Stockholm, named by Cleve *A. Stoschii*, is *A. angulatus* var. *neogradensis*, and Weissflog's 'Gazelle' specimen, also named *A. Stoschii*, is *A. amœnus* var. *hungarica* with 5 processes.

Habitat: Cambridge deposit, Barbadoes (Greville!).

Var. *Stoschii*. *A. Stoschii* Janisch in Sch. Atl., pl. xxxiv. fig. 11. —Diam. 0·165 to 0·175 mm. Central portion flattened to about 5/7 of radius, outer edge more distinct, convex on compartments; inflations short, abrupt; slope to border gentle. Markings 5 in 0·01 mm., concentric rows less distinct. Primary rays indistinct towards centre. Processes 6, cylindrical, insertion about 1/6 of radius from circumference.

Habitat: Cambridge deposit, Barbadoes (Greville! Johnson!); 'Gazelle' Exped. (Janisch).

Var. *canariensis*.—Diam. 0·14 mm. Central portion flat to 3/7, rarely to 2/3 of radius; inflations more distinct, rarely short. Central space larger (1/9 to 1/14 of diam.), sometimes with short extensions into apices of compartments. Markings 4 in 0·01 mm., without interspaces, secondary fringe-like rows around processes more evident. Border striæ coarse, 8 to 10 in 0·01 mm. Processes 7, free ends rounded, constriction median.—Pl. VI. fig. 6.

Norman proposed to erect a new species for these valves; Hardman has regarded them as a var. of *A. angulatus*.

Habitat: Teneriffe (Norman! Hardman! Weissflog!); 'Gazelle,' Exped. (Weissflog!).

A. spectabilis Grev., Trans. Mic. Soc. Lond., 1863, p. 71, pl. v. fig. 16.—Diam. 0·075 to 0·1225 mm. Surface rising to 1/3, or flat to about 1/4 of radius; highest zone about 1/5 of radius broad, straight, or slightly concave outwards on compartments; inflations extending to border, tapering but slightly inwards, their edges abrupt; slope to border gentle. Colour pale grey, darker about primary rays and middle of compartments. Central space pentagonal, 1/16 to 1/25 of diam. broad, sides convex inwards, hyaline. Markings oval or bluntly angular, 6 in 0·01 mm., least crowded towards centre, decreasing but slightly towards border, rows transverse or oblique on inflations. Primary rays distinct only outside highest zone where the rows suddenly diverge, again converging somewhat towards processes. Border striæ 10 in 0·01 mm., 1/21 to 1/24 of radius broad, a narrow clear area between it and the radial rows. Processes 5, insertion 1/4 to 1/5 of radius from circumference. Constriction median, distinct, free ends convex.—*A. grandis* Walker, New and Rare Diats., p. 3, pl. i. fig. 8. The scar of broken-off process is oval.

Habitat: Cambridge deposit, Barbadoes (Greville! Johnson!).

Var. *depressa*.—Diam. 0·115 mm. A small, rounded depression on compartments near outer edge of highest zone, and about 1/12 of radius broad. Markings rounded, 6 to 8 in 0·01 mm., faintly traceable across depressions, more irregular near central space. Primary rays with wider median space. Processes 5, ends truncate.—Pl. VII. fig. 6.

Habitat: Cambridge deposit, Barbadoes (Johnson!).

A. quadrans Sch., Atl., pl. xxxv. fig. 10.—Diam. 0·1125 mm. Surface, central portion flat to 1/8 of radius, with outer edge distinct, round or somewhat irregular; primary rays on same plane to processes, inflations distinct, compartments flat for about outer 2/3 of radius from border. Colour pale grey. Central space irregularly quadrate, 1/22 of diam. broad. Markings polygonal, rounded close to central space, outlines delicate, 5 in 0·01 mm., rows straight, radial, secondary rows distinct on raised areas. Primary rays well marked, rows diverging for 1/3 of length from inner ends, thence remaining parallel or converging but slightly towards processes. Border narrower by about 1/2 opposite processes, hyaline, about 1/23 of radius broad. Processes 4, insertion about 2/11 of radius from circumference, obovate or subclavate, beyond distal ends a subcrescentic line sometimes visible, clear space at base large, sometimes asymmetrical.

Habitat: Simbirsk Polirschiefer (Weissflog!).

A. dispersus sp. n.—Diam. 0·15 to 0·175 mm. Surface, central portion flat for about 1/5 to 4/9 of radius, with outer edge slightly convex on compartments, and angular at primary rays. Central space quadrate, indistinct, about 1/40 of diam. broad. Markings polygonal towards centre, rounded towards border, 4 to 6 in 0·01 mm., outlines indistinct, central dot minute, rows radial, straight, separated

by distinct hyaline radial interspaces. Primary rays well marked, beyond central area sometimes rising slightly to processes, the rows diverging widely outwards, again converging more distinctly towards processes, and continued to border. Border striæ distinct, 8 in 0·01 mm. Processes 4, insertion about 1/6 of radius from circumference, symmetrical.—Pl. V. fig. 9. *A. spectabilis* Grove & Sturt, Journ. Quek. Mic. Cl., 1887, p. 14. The scar of broken-off processes is oval.

Habitat: Oamaru deposit (Grove! Doeg!).

A. angulatus Grev., Trans. Mic. Soc. Lond., 1863, p. 71, pl. v. fig. 15.—Valve rarely elliptical. Diam. 0·09 to 0·325 mm. Surface rising for 1/3 to 1/2 of radius, highest zone distinct, 1/6 to 1/10 of radius broad, compartments from highest zone to zone of processes first slightly convex, then concave, flat towards border; primary rays sloping uniformly downwards to processes. Colour pale or dark grey. Central space round or angular, 1/15 to 1/18 of diam. broad, punctate. Markings round or angular, 3½ to 4 in 0·01 mm., outlines delicate, central dot brilliant, interspaces punctate, rows subradial or subparallel on compartments. Primary rays distinct, rows not diverging. Border striæ 6 to 8 in 0·01 mm., about 1/30 of radius broad, indistinct. Processes 5 to 16, insertion 2/9 to 2/15 of radius from circumference, proximal portion somewhat larger than distal, constriction submedian (towards apex), free ends rounded.—Sch. Atl., pl. xxxiv. figs. 7–8; pl. ciii. fig. 2; pl. cv. fig. 7. The scar of broken-off process is oval.

Habitat: Cambridge deposit, Barbadoes (W. J. Gray!); shell cleanings, S. America (Hardman!); Pacific Ocean (Weissflog!); 'Gazelle' Exped. (Janisch!); Oamaru deposit, New Zealand (Grove & Sturt!).

Var. *hungarica*. *A. hungaricus* Pant., Fossil. Bacil. Ung., p. 57, pl. xxv. fig. 231.—Diam. 0·15 to 0·225 mm. Surface more sharply crateriform, rising for 1/5 to 2/9 of radius, highest zone 1/7 to 2/7 of radius broad, when wide angular at primary rays; inflations more prominent. Central space irregular, 1/35 to 1/90 of diam. broad. Markings subquadrate, 4½ in 0·01 mm., rows parallel on each compartment, secondary concentric bands distinct to outer edge of highest zone, outside of this more straight across compartments. Primary rays more prominent. Border striæ 8 to 10 in 0·01 mm., 1/35 to 1/45 of radius broad. Processes 7 or 8, cylindrical, constriction slight, proximal ends more opaque, free ends truncate, no clear space at base.

Habitat: Szent Peter deposit, Hungary (Pantocsek! Hardman! Grove!); Szakal and Kékkö deposits, Hungary (Pantocsek!); Santa Marta deposit (Griffin!).

Var. *neogradensis*. *A. neogradensis* Pant., ibid., p. 59, pl. xxv. fig. 227.—Diam. 0·125 to 0·19 mm. Surface flat for 1/5 to 1/7 of radius, highest zone 1/8 of radius broad, outer edge convex outwards on compartments, angular on both sides at primary rays, more rarely on outer only; inflations short. Central space irregularly angular,

1/35 to 1/50 of diam. broad, coarsely punctate. Markings as in var. *hungarica*, but 4 in 0·01 mm., the rows subradial. Primary rays inconspicuous. Processes 7 to 9, insertion 1/6 to 1/8 of radius from circumference.—*A. subangulatus* Pant., ibid., p. 60, pl. ii. fig. 11; pl. xxviii. p. 276.

Greville united in his collection under *A. angulatus* specimens of *A. spectabilis*, *A. decorus*, and *A. amœnus* var. *subdecora*. Some Kékkö forms of the var. *neogradensis* are transitional to *A. amœnus*.

Pantocsek's original specimens of *A. subangulatus*, with which he also associates Kinker's Kékkö valve (Sch. Atl., pl. cv. fig. 8), are worn forms of this var.

Habitat: Szent Peter, Szakal, and Kékkö deposits, Hungary (Pantocsek!); Santa Marta deposit (Weissflog! Griffin!).

Var. *plana*.—Diam. 0·1075 mm. Surface rising to about semiradius, highest zone convex, broad, outside of this primary rays but slightly elevated above level of compartments. Colour light grey towards centre, most opaque about semiradius, and on semicircular, centrally convex areas surrounding the processes. Central space round, about 1/12 of diam. broad. Markings rounded, or bluntly angular, in irregular concentric bands towards central space. Processes 11, insertion about 1/9 of radius from circumference.

Habitat: Jackson's Paddock, Oamaru (Kinker!).

A. rotulus sp. n.—Diam. 0·195. Surface flat at central space, thence rising for about 1/4 of radius, highest zone 1/4 of radius broad, its outer edge abrupt and primary rays in same plane with it to processes; inflations abrupt, about 1/4 of radius in greatest breadth, at each angle an irregularly rounded lobe with longer axis at right angles to corresponding ray, compartments flat near border. Colour pale to slaty grey, mottled with darker spots, darker at sides of inflations. Central space irregularly round, about 1/16 of diam. broad, faintly punctate. Markings rounded, 3 in 0·01 mm., interspaces unequal, punctate, rows subradial to outer edge of highest zone, beyond this more parallel, straight or forming wide curves. Primary rays within highest zone undifferentiated, outside of this distinct. Border striæ, 8 in 0·01 mm., about 1/26 of radius broad, inner edge distinct. Processes 8, insertion about 1/8 of radius from circumference, proximal part rounded, distal cylindrical, free ends convex. Allied to *A. angulatus* through its var. *hungarica*.—Pl. V. fig. 10.

The scar of the broken-off process is rounded.

Habitat: Newcastle deposit, Barbadoes (Firth!).

A. grevilleanus Norman, Grev., Trans. Mic. Soc. Lond., 1864, p. 10, pl. i. fig. 1.—Diam. about 0·0275 mm. Surface with several distinct concentric zones to about 1/4 of radius from centre, the area adjoining primary rays sharply defined, with sides straight, and converging inwards. Central space circular, about 1/28 of diam. broad, hyaline. Markings round or oblong near centre; rows radial, beyond central zonate area forming evident oblique curved intersecting secondary rows, on area adjoining primary rays are wart-like cushions,

each with a cluster of 4 to 6 larger markings, and at outer end of each ray is a small sharply defined area extending symmetrically on both sides of process, and bearing coarse radial striæ. Primary rays distinct, the rows diverging slightly outwards. Border striæ delicate, about 1/27 of radius broad. Processes 10, insertion about 1/16 of radius from circumference, space at base small, hyaline.

Habitat: Moron deposit, Seville (Norman).

§ 4. Areolati.

Slope to border sometimes steep. Inflations absent or rudimentary. Markings pearly, central dot round or oval, distinct, rows radial, slightly concave towards and adjoining primary rays. Primary rays straight or with slight bendings. Border striated.

A. apedicellatus sp. n. *Aulacodiscus?* sp.—Sch. Atl., pl. ciii. fig. 4. —Diam. 0·085 to 0·225 mm. Surface flat for 1/3 to 2/3 of radius and just within border, intervening slope steep. Colour pale slaty grey, darker at outer edge of central area. Central space angular, outline irregular, rarely regular, 1/30 of diam. broad, short diverticula passing into apices of compartments; rarely somewhat excentric. Markings polygonal, 4 in 0·01 mm., rows deflected at origin of shorter rows, rarely subfasciculate, secondary oblique rows evident. Primary rays 7 to 13, distinct, sometimes asymmetrical, rows in contact, areolæ enlarging towards outer ends, where they are cuneate with long axis oblique or radial. Border indistinct. Processes absent, but outer ends of rays at 1/5 to 3/8 of radius from circumference, and opaque when centre is in focus.

Habitat: Simbirsk Polirschiefer (Kinker! Cleve! Rae!).

A. cellulosus Grove & Sturt, Journ. Quek. Mic. Cl., 1887, p. 8, pl. ii. figs. 8, 9.—Diam. 0·09 to 0·23 mm. Surface, central portion flat for 1/3 to 2/3 of radius, rarely almost to processes, with outer edge bluntly angular and sides convex. Colour pale grey, darker towards border. Centre with an inconspicuous rosette, 1/12 to 1/23 of diam. broad. Markings large, irregular, polygonal, 2 to 3 in 0·01 mm., decreasing somewhat suddenly towards border, around the outer edge a band of minute puncta, secondary oblique rows distinct. Primary rays indistinct, rows in contact. Border striæ sometimes oblique, 6 to 8 in 0·01 mm., inner edge indistinct. Processes 4 to 9, insertion 1/9 to 1/12 of radius from circumference, constriction median, wide, shallow, free ends rounded, no clear space at base.—*A. cellulosus* var. *plana* Grove & Sturt, ibid., p. 140.

The valves named var. *plana* Grove & Sturt are flat to processes and the slope to the border is still more gentle.

Habitat: Oamaru deposit, New Zealand (Grove & Sturt! Rae!).

A. elegans Grove & Sturt, Journ. Quek. Mic. Cl., 1887, p. 140, pl. xii. fig. 30.—Sometimes subcircular, diam. 0·105 to 0·175 mm. Surface flat to zone of processes, outer edge faintly angular at processes; slope to border steep. Colour pale grey. Central space

irregularly angular, indistinct, 1/27 to 1/35 of diam. broad, edges uneven. Markings mostly hexagonal, largest about semiradius, 4 in 0·01 mm., decreasing gradually to border, central dot indistinct; rows straight, secondary rows inconspicuous, rarely with large irregular clear spaces around central space. Primary rays distinct, the areolæ more regular than those on compartments, increasing for 1/2 to 2/3 of radius, thence diminishing towards processes. Border striæ moniliform, 6 in 0·01 mm., in part continuous with radial rows. Processes 5 to 7, insertion 1/5 to 1/7 of radius from circumference, minute subclavate, free ends rounded or truncate, no clear space at base.—*A. decorus* Grove & Sturt, ibid., 1887, pp. 8, 146.

Habitat: Oamaru deposit, New Zealand (Grove & Sturt!).

A. radiosus Grove & Sturt, Journ. Quek. Mic. Cl., 1887, p. 140, pl. xii. fig. 33.—Diam. 0·19 to 0·27 mm. Surface flat for about 1/3 of radius. Colour pale bluish grey, or darker at centre and border. Centre with an irregular inconspicuous rosette 1/25 to 1/72 of diam. broad, formed by unequal areolæ. Markings polygonal, 4 in 0·01 mm., central dot faint, rows somewhat convergent only about processes. Primary rays inconspicuous, recognized towards centre only when traced inwards, the rows diverging slightly near outer ends. Border striæ 12 in 0·01 mm., 1/25 to 1/36 of radius broad, its inner edge indistinct. Processes 5 to 7, insertion about 1/5 to 1/8 of radius from circumference, clavate, constriction wide, shallow, clear space at base small, rounded.

The scar of the broken-off process is obovate.

Habitat: Oamaru deposit, New Zealand (Grove & Sturt!).

A. crux Ehrb., Mon. Ber. Ak., 1844, p. 76.—Diam. 0·0875 to 0·0925 mm. Surface flat along primary rays to processes, and to about 1/2 of radius on compartments; inflations rudimentary, intervening concavities distinct, shallow. Colour pale grey, darker towards centre and border. Central space angular or elongate, 1/28 of diam. broad, hyaline, rarely sub-obsolete. Markings polygonal, 4 in 0·01 mm., central dot faint, rows at centre of compartments together forming an indistinct cruciform figure, alternate with rays, secondary rows evident on inflations, sometimes irregular and indistinct. Primary rays distinct, cruciform, rows diverging in outer 2/5 of their length. Border indistinct, striæ coarse, continuous with radial rows. Processes 4, insertion 1/7 to 1/8 of radius from circumference, minute free ends, rounded, clear space at base minute.—Ehrb. Mikrog., p. 8, pl. xviii. fig. 47; Grunow, Denk. Wien. Ak., 1884, p. 69; Sch. Atl., pl. xxxiii. fig. 3. *Eupodiscus crux* Kütz., Sp. Alg., p. 135.

The scar of the broken-off processes is elliptical or obovate. Affinity to *A. Comberi*, pointed out by Ralfs, is remote.

Habitat: Richmond, Virginia (Kinker! Weissflog!); Petersburg, Virginia (Ehrenberg); Sta. Barbara deposit (Rae!); Szent Peter deposit (Grove!); Simbirsk Polirschiefer (Cleve!).

Var. *subsquamosa* Grun. MS.—Diam. 0·0775 to 0·19 mm. Surface with outer edge of elevated area more distinct, inflations more

evident. Central rosette inconspicuous, 1/10 to 1/19 of diam. broad. Markings more irregular, more pearly, 3 in 0·01 mm., decreasing suddenly at 1/5 to 1/7 of radius from border, secondary subconcentric rows towards centre indistinct. Primary rays with rows less divergent. Border hyaline, 1/17 to 1/38 of radius broad, inner edge definite. Processes 4, rarely 3, insertion 1/6 to 5/17 of radius from circumference, larger, constriction median, wide, shallow, no clear space at base.—Pl. VI. fig. 8.

The scar of broken-off process is narrow and elongate.

Habitat: Oamaru deposit, New Zealand (Grove & Sturt! Rae!).

A. margaritaceus Ralfs, in Pritch. Inf., p. 844.—Diam. 0·1 to 0·415 mm. Surface flat to processes or to 1/2 of radius, sometimes concave at centre, highest zone angular at processes, 1/8 to 1/3 of radius broad. Colour pale grey, border darker. Central space angular, elliptical, rarely sub-obsolete, 1/10 to 1/60 of diam. broad, hyaline, rarely punctate. Markings rounded or polygonal, pearly, 3½ in 0·01 mm., moniliform towards border, dot often unilateral, interspaces hyaline. Primary rays with rows in contact or diverging from semiradius, sometimes interrupted. Border striæ 8 in 0·01 mm., 1/30 to 1/40 of radius broad. Processes 3 to 12,* insertion 1/4 to 1/11 of radius from circumference, small, clavate, constriction shallow, about 1/3 of length from base, clear space at base small, length about 2½ times breadth.—Sch. Atl., pl. xxxvii. figs. 4, 5; pl. xcii. fig. 12; pl. civ. figs. 7, 8; pl. cv. figs. 1, 2, 4. *A. crux* Ehrb. Mikrog., pl. xxxv. A. 16 fig. 2. *A. samoensis* Grun. 1883, Möller, Preisverzeichniss Mikr. Präp. fide Cleve. *A. crux* var. *peruana* Grun., Denk. Wien. Ak., 1884, p. 69; Sch. Atl., pl. xxxiii. figs. 1–3. The scar of the broken-off process is oval.

Habitat: Patos Island guano (Johnson! Browne! Weissflog!); California guano (Greville! Norman!); Mejillones, Peru (Kinker! Hardman!); Sta. Marta deposit (Hardman! Weissflog!), Sta. Monica deposit (Joshua!); Calvert Co., Maryland (Weissflog!); California (Cleve! Grundler!); New Caledonia (Kinker!); Sierra Leone (Hardman!); Rio Janeiro (Hardman! Firth!); Java ex *Holothuriâ edule* (Kinker! Weissflog!); Samoa (Cleve!); Labuan (Weissflog! Cleve!); San José Pearl Islands (Cleve!).

Var. *Debyi.*—*A. Debyi* Pant., Fossil. Bacil. Ung., p. 58, pl. xxv. fig. 226. Diam. 0·205 to 0·6 mm. Surface flat for 3/8 of radius, slope to border steep. Primary rays inconspicuous, the rows diverging for about outer 1/3 of length. Processes 4 to 11, insertion 1/5 to 1/9 of radius from circumference, much larger, free ends flattened, proximal portion about 3/5 distal in breadth, clear space at base small, length about 1½ times breadth.—Sch. Atl., pl. civ. fig. 9.

Habitat: Mejillones, Peru (Kinker!); California Guano (Greville!); Oamaru deposit (Grove & Sturt! Rae!).

Var. *elongata.*—Diam. 0·375 mm. Surface rising gradually for

* The number on valves of a single frustule is sometimes different, e. g. four on the one, five on the other.

3/5 of radius. Central space rounded, 1/17 diam. broad. Markings 3 in 0·01 mm., interspaces towards centre hyaline. Primary rays with rows diverging in outer 1/6 of length. Processes 6, insertion about 1/6 of radius from circumference, sides concave, breadth at proximal and distal ends subequal, length about $3\frac{1}{3}$ times breadth, narrow.—Sch. Atl., pl. xxxvii. figs. 1–3.

Schmidt regards this, on what appears to me to be insufficient grounds, as perhaps a new species.

Habitat: California, Pacific Coast (Cleve!).

Var. *robusta* Witt, Sch. Atl., pl. xxxvii. figs. 6, 7.—Diam. 0·51 mm. Surface rising to zone of processes, slope to border steep. Markings $1\frac{1}{2}$ to 2 in 0·01 mm., often with two lateral dots. Primary rays indistinct towards centre, often interrupted. Processes 6 to 17, insertion 1/5 to 1/17 of radius from circumference, large, between insertion and margin two almost parallel dark bands.—Sch. Atl., pl. cv. fig. 3.

Habitat: Santa Monica deposit (Rae!); Yokohama (Witt!).

Var. *distans*.—Diam. as in var. *Debyi*. Central space elliptical to quadrate, about 1/160 of diam. broad. Markings 2 to 3 in 0·01 mm., largest at middle of radius, decreasing towards centre and border. Primary rays inconspicuous. Processes 4, insertion 2/7 of radius from circumference, proximal part larger than distal.—Sch. Atl., pl. civ. fig. 6.

Schmidt regards this as worthy to be a distinct species.

Habitat: Calvert Co., Maryland (Weissflog!).

Var. *Kinkeri*.—*A. Kinkeri* Sch. Atl., pl. cvi. figs. 4, 5. Diam. 0·23 to 0·25 mm. Surface flat to border. Markings $2\frac{1}{2}$ in 0·01 mm., the radial axis shorter than that at right angles to radius, brilliant, decreasing suddenly outside zone of processes. Primary rays sometimes interrupted. Processes 4 or 5, insertion 1/4 to 1/5 of radius from circumference, length 3 times breadth.—*A. catenarius* Witt, Sch. Atl., pl. cv. fig. 5, pl. cvi. fig. 3. The scar of the broken-off process is oval.

Habitat: California, near Sta. Monica (Kinker!).

Var. *undosa*, Grove & Sturt MS. Diam. 0·23 to 0·445 mm. Surface, central portion flat, stellate with angles at processes, and sides deeply concave between these. Markings $2\frac{1}{2}$ in 0·01 mm. Primary rays distinct. Processes 9 to 14, insertion 1/9 to 1/11 of radius from circumference, obconical, free ends but little rounded.

The scar of the broken-off process is obovate.

Habitat: Jackson's Paddock, Oamaru (Grove!).

Var. *Mölleri*.—*A. Mölleri* Grun., Sch. Atl., pl. xxxiii. fig. 14. Diam. 0·11 to 0·25 mm. Surface as in var. *undosa*, but angles at processes more obtuse. Markings 3 to 4 in 0·01 mm., rows at middle of compartments cruciform. Primary rays cruciform. Processes 4, rarely 5, insertion 1/3 to 1/4 of radius from circumference, small hourglass-shaped constriction sharp.—Sch. Atl., pl. xxxv. fig. 6; pl. xxxvii. fig. 8; pl. xli. fig. 12; pl. cii. figs. 1, 2.

The scar of the broken-off process is elliptical.

Habitat: Calvert Co., Maryland (Kinker! Cleve!); Nottingham deposit, Maryland (Greville! Norman! Johnson! Cleve! Weissflog!); Bermuda tripoli (Greville! Weissflog!).

Var. *distincta*.—*A. Mölleri* var. Sch. Atl., pl. xcii. fig. 13.—Surface showing an elevated polygonal central area with distinct outwardly concave edges. Central space sharply defined, about 1/35 of diam. broad. Markings somewhat smaller than in var. *Mölleri* (fid. Sch.). Primary rays conspicuous, the markings in the rows with longer axis at right angles to length of ray. Border with inner edge indistinct, more opaque. Processes 5, insertion about 1/4 of radius from circumference, clear space at base well marked.

Habitat: Nottingham deposit (Janisch).

Var. *inconspicua*.—Diam. 0·1125 to 0·2 mm. Central space 3–4-angled, finely punctate. Markings $2\frac{1}{2}$ to 4 in 0·01 mm., increasing for about 7/8 of radius, then decreasing suddenly to border. Primary rays indistinct. Processes 7, insertion 1/10 of radius from circumference, as small conical protuberances with rounded ends.—Pl. VI. fig. 3.

Habitat: New South Wales (R. Rattray!); Sydney (Cleve!).

Var. *tenera*.—*A. crux* var. *tenera* Witt, Simb. Polirsch., p. 19, pl. vi. fig. 10. Diam. 0·095 to 0·1125 mm. Surface flat to processes. Central space round, 1/38 of diam. broad. Markings 8 in 0·01 mm., rows deflected at processes. Primary rays distinct. Processes 3 or 4, minute, insertion about 1/3 of radius from circumference.—Sch. Atl., pl. cii. fig. 4.

Habitat: Chincha Island guano (Arnott!); *Haliotis* shell scrapings, California (Weissflog!); Simbirsk Polirschiefer (Witt!).

A. scaber Ralfs, in Pritch. Inf., p. 844.—Diam. 0·08 to 0·27 mm. Surface flat from centre to processes, sides convex on compartments. Colour light, lurid. Central space angular, 1/34 to 1/84 of diam. broad, hyaline. Markings polygonal, 4 in 0·01 mm. decreasing suddenly towards border. Apiculi numerous, short, irregularly placed, sometimes chiefly between processes, rare outside of latter. Primary rays distinct, rows in contact or diverging but little at outer ends. Border striæ 6 to 8 in 0·01 mm., 1/14 to 1/42 of radius broad. Processes 3 to 5, insertion 1/4 to 1/5 of radius from circumference, hourglass-shaped, constriction well marked, length 2 to $2\frac{1}{2}$ times breadth.—Sch. Atl., pl. xxxiii. figs. 4–8. *A. crux* Ehrb. var., Habirshaw Cat. Diat., § *Aulacodiscus*; *A. ternatus* Janisch, Abh. Sch. Ges. väter. Cult., 1861, p. 161, pl. ii. fig. 4; *A. crux* Janisch (not Ehrb.), ibid. 1861, p. 161, pl. ii. figs. 1–3; 1862, pl. ia. fig. 12; *A. quinarius* Janisch, ibid., 1861, p. 162. The scar of the broken-off process is elliptical.

Habitat: Peruvian guano (Ralfs! Macrae! Greville! Johnson! Weissflog! Schmidt, Janisch, Browne); North Celebes, Ichaboe, and Chincha guanos (O'Meara!).

Var. *jonesiana.** *A. jonesianus* Grev., Trans. Mic. Soc. Lond., 1862, p. 24, pl. ii. fig. 5.—Diam. 0·261 mm. Surface flat to 3/10 of radius. Central space oblong or angular, limiting areolæ larger than those on compartments. Markings mostly hexagonal, rows deflected at processes, rarely subfasciculate, when apices are in focus elongated, opaque areas are visible opposite ends of shorter rows. Processes 5 to 8, insertion 1/6 to 1/7 of radius from circumference, proximal portion rounded, distal cylindrical, length 4 times breadth.

Habitat: "Guano" (Macrae!); Bolivian guano (Rae!).

A. secedens Sch. Atl., pl. cvi. fig. 2. Diam. 0·24 mm. Surface flat to about 3/10 of radius; highest zone occupying middle third, angular at processes, sides straight, abrupt; slope to border steep. Colour pale grey. Central space angular, about 1/90 of diam. broad, limiting markings equal. Markings polygonal, 4 in 0·01 mm., central dot inconspicuous. Primary rays distinct, the rows diverging slightly at outer ends. Border striæ 8 in 0·01 mm., about 1/24 of radius broad, inner edge distinct. Processes 5, symmetrical, insertion about 1/5 of radius from circumference, proximal portion short, constriction shallow, free ends knob-like, no clear space at base.

Habitat: Panama shell-scrapings (Kinker!).

A. compactus sp. n.—Diam. 0·175 to 0·2 mm. Surface, central portion flat to processes, sides deeply concave outwards between these; slope to border gentle. Colour highest area lurid, remainder dark grey. Central space rounded, 1/18 to 1/20 of diam. broad, coarsely punctate. Markings polygonal, 4 in 0·01 mm., rows parallel to that at middle of compartments or subradial, secondary concentric bands inconspicuous towards centre. Primary rays distinct, rows diverging in outer 1/4 of length. Border granules 6 to 8 in 0·01 mm. in a single band, or striæ 8 in 0·01 mm., sometimes a narrow clear space at inner side. Processes 10, insertion 1/7 to 1/8 of radius from circumference, subcylindrical, constriction median, slight.—Pl. V. fig. 8.

Habitat: Sta. Maria deposit (Kinker!); Newcastle deposit, Barbadoes (Firth!)

A. patens sp. n.—Diam. 0·27 mm. Surface flat from centre for about 1/11 of radius, thence sloping gently to a slightly angular clear zone, about 1/28 of radius broad, and from this somewhat more steeply to border, outside of the clear zone the primary rays slightly elevated. Colour pale grey. Central space round, about 1/22 of diam. broad, punctate. Markings polygonal and in contact, 3 in 0·01 mm., decreasing gradually from flat central portion to clear zone, thence subequal to border, central dot brilliant, rows subradial within, more nearly parallel outside of clear zone. Primary rays inconspicuous within, distinct outside of clear zone, the rows diverging slightly towards outer ends. Border striæ coarse, 6 in 0·01 mm., about 1/55 of radius broad, its inner edge indistinct, separated by a narrow punctate space from the markings on the compartments. Processes 13, insertion

* Dedicated by Greville to Prof. Jones, University, Calcutta, formerly associated with Dr. Macrae in the investigation of the Indian Diatomaceæ.

about 1/11 of radius from circumference, short but stout, length subequal to breadth, space at base small, punctate.—Pl. VI. fig. 2.

Habitat: Jackson's Paddock, Oamaru (Kinker! Hardman! Grove!).

§ 5. Septati.

Surface of 3 portions—a central triangular, rarely elliptical, sharply defined, sides convex outwards, with angles at primary rays, a median highest, convex, bluntly angular, with outer edge more faint, an outer sloping gradually to border. Colour pale grey. No central space or rosette. Processes with clear space at base large, V-shaped.

A. septus Sch. Atl., pl. xxxvi. figs. 19–21.—Diam. 0·035 to 0·04 mm. Surface, central area sometimes elliptical with ends of major axis at primary rays, extending for 3/8 to 5/14 of radius median about 1/6 of radius broad. Markings on central area polygonal outlines faint, irregular, 6 in 0·01 mm., with a few small round isolated granules, from median area decreasing slightly outwards, 8 in 0·01 mm. Primary rays sometimes interrupted, the rows prolonged past sides of processes to border. Border striæ 8 in 0·01 mm., 1/14 to 1/16 of radius broad. Processes 2 or 3, insertion 1/3 to 1/4 of radius from circumference, as obovate dark spots.

Habitat: Simbirsk Polirschiefer (Witt! Weissflog!).

A. Schmidtii Witt., Simb. Polirsch., p. 21, pl. vii. figs. 1, 2.—Diam. 0·07 to 0·1025 mm. Surface, central area flat, rarely lowest at centre, extending for about 1/3 of radius, median portion 1/3 to 1/4 of radius broad, with angles passing round outer side of processes. Markings on central portion polygonal, subequal, 4 in 0·01 mm., forming straight rows near and at right angles to its edge, the round isolated granules placed about its middle, on median and outer portions round or compressed, 4 in 0·01 mm., rows straight only at middle of compartments, elsewhere curving towards processes. Primary rays absent. Processes 3, insertion 2/5 of radius from circumference, narrow margins, concave, free ends rounded, length 3 to 5 times breadth.—Sch. Atl., pl. ci. figs. 1–3.

The scar of the broken-off process is elliptical.

Habitat: Simbirsk Polirschiefer (Witt! Weissflog! Hardman!). Sysran deposit, Siberia (Grove!).

Var. *quatuor-radiata*. *A. septus* forma *quatuor-radiata* Pant., Fossil Bacil. Ung., p. 60, pl. x. fig. 84.—Diam. 0·0875 mm. Surface, central area rounded, flat, highest, extending to 5/17 of radius, adjacent zone hyaline, median portion quadrate. Markings on central portion reniform, irregular, outside hyaline zone round or oblong, 4 to 6 in 0·01 mm. Border indistinct. Processes 4, insertion about 5/18 of radius from circumference, minute.

Habitat: Simbirsk Polirschiefer (Pantocsek!)

By discovery of additional specimens *A. Schmidtii* may be shown to be but a var. of *A. septus*, as *A. Kinkeri* and *A. Mölleri* are of *A. margaritaceus*.

§ 6. Mirabiles.

Highest zone distinct, angular at processes. A reticulum or irregular ridges. Primary rays indistinct within highest zone. Border striæ faint. Processes with clear area at base small.

A. archangelskianus Witt., Simb. Polirsch., p. 18, pl. vi. figs. 11, 12.—Diam. 0·1025 to 0·195 mm. Surface with highest zone at 1/4 to 1/8 of radius from centre, primary rays rising slightly outwards; inflations reaching border, compartments flat near border. Colour in lighter or dark grey zones. Central space angular, 1/16 to 1/33 of diam. broad, clear. Markings rounded within highest zone and about middle of compartments, elsewhere more crowded and angular, 6 in 0·01 mm., secondary oblique rows obvious on inflations which bear irregular blunt ridges. Primary rays with rows widest about middle. Border striæ 12 in 0·01 mm., 1/20 to 1/30 of radius broad, with a median line curving inwards at each inflation. Processes 5, rarely 6, symmetrical, insertion 1/5 to 1/6 of radius from circumference, proximal portion much larger than distal, constriction distinct, free ends rounded.—Sch. Atl., pl. ci. figs. 7–11; Pant., Fossil Bacil. Ung., p. 60, pl. x. fig. 83.

Habitat: Simbirsk Polirschiefer (Witt! Cleve! Rae! Hardman!).

A. superbus Kitton, Month. Mic. Journ., 1873, p. 205, pl. xxxviii. fig. 1.—Diam. 0·175 mm. Surface with highest zone 1/17 of radius broad at about 1/3 of radius from centre, from this the primary rays continuing on same plane to processes; inflations reaching border, merging gently into intervening areas. Colour pale grey, edges of highest zone and inflations darker. Central space irregularly angular, 1/17 diam. broad, clear. Markings polygonal, rounded near centre, 6 to 8 in 0·01 mm., rows radial within, almost parallel outside of, highest zone, secondary irregular concentric bands near central space. Reticulum distinct, absent only from central space, highest zone, outer ends of primary rays and border, meshes smallest towards centre. Primary rays with rows diverging slightly near processes. Border striæ 6 to 8 in 0·01 mm., about 1/33 of radius broad, inner edge sharp. Processes 7, insertion 1/12 of radius from circumference, sides converging towards base, constriction slight, length 1½ to 2 times breadth.

Habitat: Clark's Cliff,* Barbadoes (Kitton! Hanwell!); "Barbadoes" (Johnson); Upper Springfield, Barbadoes (Griffin!).

A. attenuatus sp. n.—Diam. 0·1 to 0·105. Surface rising to about semiradius, thence along primary rays to processes, edges of inflations abrupt. Colour pale grey. Central space subregularly polygonal, 1/13 to 1/14 of diam. broad, hyaline. Markings polygonal, 8 to 10 in 0·01 mm., rows parallel between inflations, a few at sides of primary rays, parallel to the latter, a reticulum of subequal

* According to label on Hanwell's material; according to Kitton probably a mistake for Chalk Cliff.

meshes just visible, secondary oblique rows conspicuous at outer ends of inflations. Border indistinctly defined, striæ 10 in 0·01 mm., about 1/20 of radius broad. Processes 7, insertion 1/8 of radius from circumference, cylindrical, or tapering somewhat towards outer ends, small, free ends emarginate.—Pl. V. fig. 2.

The scar of the broken-off process is oval.

Habitat: Cambridge deposit, Barbadoes (Johnson!).

A. anthoides Sch., Atl., pl. ciii. fig. 1.—Diam. 0·1125 mm. Surface rising gently for about 1/5 of radius to highest zone, the latter about 2/5 of radius broad; slope near border gentle, outer ends of inflations sharply defined by a curved dark line. Colour pale grey, darker towards border. Central space pentagonal, sides inwardly convex, 1/15 of diam. broad, sometimes rounded. Markings rounded, 6 in 0·01 mm., smaller near central space, rows on peripheral region in fasciculi, separated by wide irregular interspaces, more hyaline than those between the component rows of the fasciculi. Primary rays with rows diverging from inner ends, outside highest zone interspace much wider. Border striæ 10 to 12 in 0·01 mm., about 1/23 of radius broad. Processes 5, insertion 1/3 to 2/7 of radius from circumference, proximal part rounded, distal subcylindrical, free ends truncate, length about three times breadth.—The scar of the broken-off process is oval.

Habitat: Barbadoes (Weissflog!).

§ 7. Spectati.

Surface flat or slightly depressed at centre, highest zone angular at processes, edges concave outwards on compartments, slope to border steep, sometimes gentle; inflations as low mammillations beneath processes. Central space punctate, granulate or hyaline.

A. polygonus * Grun., Pant. Fossil. Bacil. Ung., p. 59, pl. xxvi. fig. 236. Valve polygonal, margin of compartments slightly concave. Diam. 0·182 to 0·35 (?) mm. Surface flattened from centre almost to processes, concavities between the latter shallow. Colour pale grey, darker at border. Central space inconspicuous, 1/16 to 1/18 of diam., broad. Markings round, outlines delicate, 3 to 4½ in 0·01 mm., rows radial, straight. Primary rays indistinct. Border with coarse striæ, 6 to 8 in 0·01 mm. Processes 10 to 12, insertion 1/15 to 1/23 of radius from circumference, conical, free ends truncate, no clear space at base, length 2¼ times breadth.—*A. polygonus* var. *polygibba* Grun., Pant., ibid., pl. xxvi. fig. 237.

Habitat: Szent Peter deposit (Grunow); Oamaru deposit (Pantocsek!).

A. amœnus Grev., Trans. Mic. Soc. Lond., 1864, p. 10, pl. i. fig. 3. Diam. 0·07 to 0·28 mm. Surface with highest zone 1/4 to 1/8 of radius broad, outer edge distinct, straight or concave between processes; inflations abrupt on peripheral side. Colour pale grey,

* Of this species only Pantocsek's fragmentary Oamaru specimen has been examined.

darker at processes. Central space rounded, 1/14 to 1/22 of diam. broad. Markings round or bluntly angular, oval and oblique about processes, $2\frac{1}{2}$ to $3\frac{1}{2}$ in 0·01 mm., interspaces largest towards centre, punctate, rows subradial or more parallel, slightly bent at origin of shorter rows. Primary rays sometimes distinct, the rows diverging but little near processes. Border indistinct, rarely a clear space next its inner edge. Processes 5 to 11, insertion 1/5 to 1/9 of radius from circumference, cylindrical, tapering near base, constriction median, slight, free ends rounded.—Sch. Atl., pl. xxxiv. fig. 6; pl. xli. fig. 13. *A. pellucidus* Grev., ibid., 1864, p. 12, pl. i. fig. 5; *A. amœnus* var. *sparso-radiata* Grove & Sturt, Journ. Quek. Mic. Cl., 1887, p. 9.

Habitat: Cambridge deposit, Barbadoes (Johnson! Firth!); Oamaru deposit (Grove & Sturt!); Japan (Gründler).

Var. *hungarica* Pant., Fossil. Bacil. Ung., p. 57, pl. ii. fig. 13.—Diam. 0·085 mm. Surface flat to 1/2 of radius, highest zone 1/4 of radius broad, concavities between processes deep. Central space 1/19 of diam. broad, slightly excentric. Markings polygonal, 5 in 0·01 mm., rows subradial, not deflected at processes. Primary rays distinct. Processes 7, insertion 5/17 of radius from circumference, shorter and broader, clear area at base small.

Habitat: Szent Peter deposit (Pantocsek!).

Var. *subdecora*.—Diam. 0·075 to 0·12 mm. Surface rising for 3/5 to 5/8 of radius, outer edge polygonal with angles at centre of compartments and sides straight, a second polygonal figure more distinct with angles at processes, intervening area flat. Central space 1/15 to 1/19 of diam. broad, hyaline. Markings 5 in 0·01 mm., rows often flexed at periphery. Primary rays inconspicuous. Border striæ 10 to 12 in 0·01 mm. Processes 5 or 6, insertion 1/5 to 1/6 of radius from circumference, proximal portion bulb-like, distal cylindrical—Pl. VII. fig. 5.

Habitat: Cambridge deposit, Barbadoes (Johnson!).

Var. *minor* Grove & Sturt MS.—Diam. 0·06 mm. Surface highest and flat from centre to 7/12 of radius, adjoining zone angular at processes, between these sides convex, inflations inconspicuous. Central space quadrate, 1/24 of diam. broad, delicately punctate. Markings 4 in 0·01 mm. Primary rays cruciform. Border striæ 8 in 0·01 mm., sometimes indistinct, within it a narrow clear space. Processes 4, insertion 1/4 of radius from circumference, proximal portion rounded, distal infundibulate or slightly convex.

Habitat: Oamaru deposit (Grove!).

A. oregonus Harv. & Bail. Proc. Acad. Nat. Sci. Phil., 1853, p. 430.—Diam. 0·075 to 0·235 mm. Surface flat or slightly concave at centre, highest zone 1/4 to 1/8 of radius broad. Concavity between processes deep, rarely shallow. Colour light blue or slaty grey. Central space rounded, rarely subquadrate, 1/16 to 1/20 of diam. broad, granulate. Markings round, 4 in 0·01 mm., with finely granulate interspaces towards centre, rows parallel on each compartment. Primary rays distinct, rows diverging slightly in outer

half. Border striæ 12 in 0·01 mm., about 1/35 of radius broad, inner edge distinct. Processes 6 to 27, usually 9 to 20, insertion 1/6 to 1/7 of radius from circumference, subcylindrical, margins slightly convex.—*A. oreganus* Grev., Quart. Journ. Mic. Sci., 1859, p. 156, pl. vii. fig. 2; Sch. Atl., pl. xxxiv. figs. 4–5; *A. oregonensis* Bail. & Harv., Wilkes, Explor. Exp. § Algæ, vol. xvii. p. 176, pl. ix. fig. 6.

In 1856 Greville received authentic specimens—now in British Museum—from Bailey. In smaller valves the elevation extends to the centre, the number of primary rays is less, but the central space not always so.

Habitat: Puget Sound, Oregon (Harvey and Bailey! Greville!); California (Greville! Arnott! Weissflog! Gründler); California on *Polysiphonia* (Kitton! Kinker!); on marine algæ (Rae!); among shell scrapings (Dickie! Grove!); Bodega Bay, California (Bailey); South Sea Islands (Greville!); on *Haliotis* shell, loc. (?) (Stokes!); on *Haliotis* shell, Peru (Grove); California guano (Greville!); Monterey stone (Ralfs, Cleve!); Los Angelos, California (Cleve!).

A. intumescens sp. n.—Diam. 0·29 mm. Surface slightly concave at centre; highest zone at processes, with sides distinct, the outer bluntly angular at processes, almost straight on compartments, abrupt, beyond this a narrow somewhat steep zone with deep concavities on outer side of each process, and sides convex opposite compartments, border at a much lower level; inflations slight. Central space round, about 3/6 of diam. broad, puncta most marked at centre. Markings within highest zone round, outlines faint, central dot distinct, clear, 2½ to 3 in 0·01 mm., on highest zone more distinct crowded, interspaces punctate, largest at inner ends of short rows, rows slightly deflected at processes. Primary rays distinct, interspaces narrow. Border with a single band of granules 4 to 5 in 0·01 mm., at its inner side a narrow minutely punctate space. Processes 15, conical, sides slightly concave, large, free ends truncate, at base of each a brilliant round clear spot.—Pl. V. fig. 6.

Habitat: Oamaru deposit (Doeg!).

A. affinis Grun., Sch. Atl., pl. xxxiv. figs. 9, 10; pl. cvii. fig. 7.—Valves rarely elliptical. Diam. 0·12 to 0·47 mm. Surface flat to about 4/9 of radius, thence rising to highest zone at processes, concavities between latter distinct. Colour, centre greenish yellow, bluish about semiradius, pale or dark grey at border. Central space round, 1/14 to 1/23 of diam. broad, granulate. Markings rounded, 4 rarely 2 in 0·01 mm., compressed towards border, interspaces punctate or granulate, secondary irregular subconcentric bands obvious towards central space. Primary rays indistinct, space between the rows enlarging near processes. Border granules 6 in 0·01 mm., striæ beyond these sometimes only present, 1/24 to 1/52 of radius broad. Processes 5 to 27, insertion 1/6 to 1/13 of radius from circumference, constriction as in *A. oregonus*.—*A. Lunyaesekii* f. *minor* Pant., Fossil. Bacil. Ung., p. 59, pl. i. fig. 2, pl. xxv. fig. 229; *A. Lunyaesekii* f. *major polygona* et *polygibba* Pant. in litt.; *A. Lunyaesekii* f. *maxima* Pant., ibid.,

p. 59, pl. ii. figs. 9, 10, pl. xxv. fig. 225; *A. Chasei* Pant., ibid., p. 57, pl. xxix. fig. 294; *A. oregonus* var. *sparsius-punctata* Grun. in Sch. Atl., pl. cvii. fig. 6.

Habitat: Szent Peter deposit (Pantocsek!); Santa Monica deposit (Rae! Cleve!); Sta. Maria deposit (Rae!); *ex Holothuriis*, China * (Macrae!); Posiette Bay (Beresford!); Los Angelos, California (Cleve!); Japan oysters (Weissflog! Rae!); Yokohama (Hardman!).

Var. *Lunyacsekii*.—Diam, 0·19 to 0·23 mm. Surface with concavities between processes shallow, rarely deep. Colour pale grey with darker zones near processes. Central space irregular, 1/13 to 1/18 of diam. broad. Markings, polygonal, 3½ to 4 in 0·01 mm., interspaces near centre narrow. Border with 2 bands of oval granules, 6 in 0·01 mm. Processes 13 to 16.—*A. Lunyacsekii* f. *major* Pant. in litt.

Habitat: Kékkö and Szakal deposits (Pantocsek!).

Var. *commutata*.—Diam. 0·22 mm. Surface flat to 1/3 of radius, adjacent to this a narrow hyaline irregular zone 1/22 to 1/24 of radius broad, outside of this rising for a short distance, thence flat to processes. Colour pale grey to bluish. Markings within hyaline zone round, outside of this angular, 6 in 0·01 mm., rows subradial. Primary rays undifferentiated within hyaline zone. Border striæ 10 to 12 in 0·01 mm., about 1/55 of radius broad. Processes 19, insertion about 1/7 of radius from circumference.

Habitat: Sta. Monica deposit (Rae!).

A. pulcher† Norman, in Pritch. Inf., p. 845, pl. viii. fig. 28.—Diam. 0·1025 to 0·205 mm. Surface flat to about 3/8 of radius, thence primary rays rising gently to processes, concavity between these shallow, slope to border gentle. Colour light grey at centre, pale blue outwards for 1/2 to 2/3 of radius, thence dark grey to border. Central space rounded, 1/16 to 1/20 of diam. broad, smooth. Markings round, 4 in 0·01 mm., central dot brownish, moniliform towards border, interspaces hyaline, rows subradial to almost parallel on compartments, secondary irregular concentric bands towards centre. Primary rays distinct, straight, the rows diverging on outer 2/3 of length. Border striæ 10 to 12 in 0·01 mm., 1/40 to 1/55 of radius broad, adjacent to its inner edge a narrow hyaline space. Processes

* Specimen presented to British Museum by G. H. King. The *Holothuriæ*, though sold in the China market, are mostly, according to Dr. Macrae, from Torres Straits and the adjoining islands.

† As this species has long remained doubtful the following remarks by Kitton are of interest:—"Norman had his sample of Monterey stone from Mr. Brightwell or myself, and it was in this that he found *A. pulcher*, of which he sent me a specimen. Unfortunately I lent it to Eulenstein when he undertook at Prichard's suggestion a new edition of the diatom part of the Infusoria, and this with several others were not returned. I find several slides marked *A. pulcher*, mounted some time before I parted with Norman's preparation; it therefore seems pretty clear that I knew this form, but the valves all have a smooth centre, and not one irregularly punctate, as Ralfs describes and figures it." I have examined these specimens, and they conform to the above definition. Somewhat worn forms transitional to *A. affinis* occur in Sta. Monica deposit.

7 to 12, insertion 1/5 to 1/7 of radius from circumference, cylindrical, free ends flat or slightly convex, clear space at base minute.

Habitat: Sta. Monica deposit (Johnson! Weissflog! Rae! Cleve!); Sta. Maria deposit (Grove! Rae!); San Pedro (Kinker!).

Var. *sparse-radiata*.—Diam. 0·185 mm. Surface flat at central space, from this rising for about 5/12 of radius to highest zone, the latter about 1/4 of radius broad, convex; slope to border more steep. Markings in more widely placed parallel rows, attenuated at periphery for 1/20 to 1/25 of radius, with short rows in the intervals. Processes 11, insertion 1/7 to 1/8 of radius from circumference.

Habitat: Sta. Maria deposit (Rae!).

A. orientalis Grev., Trans. Mic. Soc. Lond., 1864, p. 12, pl. ii. fig. 6.—Diam. 0·095 to 0·35 mm. Surface rising for 2/7 to 4/9 of radius, thence flattened to highest zone, the latter 1/14 to 2/9 of radius broad, concavities between processes well marked. Colour deep brown on central space, elsewhere slaty grey, rarely hyaline. Central space round, 1/17 to 1/19 of diam. broad, usually granulate. Markings quadrate to outer edge of highest zone, 4 in 0·01 mm., beyond this rounded, rows straight, radial, deflected at processes, secondary regular concentric bands obvious. Primary rays obvious. Border with coarse striæ, inner edge indefinite. Processes 7 to 45, insertion 1/6 to 1/23 of radius from circumference, proximal and distal parts subequal, constriction median, slight, length 1½ to 2 times breadth. —Sch. Atl., pl. xxxiv. figs. 1–3. *A. orientalis* var. *nankoorensis* Grun., Reise d. Novara (Bot. Th.) Bd. i. p. 103.

The scar of the broken-off process is roundly elliptical. Sometimes confounded with *A. oregonus*. Stodder has described its central space as bluish green.

Habitat: Sandwich Islands (Greville! H. L. Smith, Weissflog!); Ceylon (O'Meara! Macrae! Clive!); Eimio (Hardman!); Point de Galle Ceylon, Vega Exp. (Cleve! Weissflog!); N. Celebes (Gründler); Labuan (Cleve!); Nicobar Islands (Macrae!); "Indian Ocean" (Macrae!); pearly shell débris loc. (?) (Norman!); off Philippine Islands, 705 fms. (Rae!).

§ 8. Inflati.

Surface flattened at centre; inflations large, sharply circumscribed, inner ends merging with raised central area. Primary rays distinct.

A. gracilis sp. n.—Diam. 0·095 mm. Surface flat to 7/19 of radius, thence primary rays rising to processes; inflations evident only at outer ends. Colour transparent, outer ends of inflations light grey. Central space indistinct, about 1/13 of diam. broad, an irregular granule at its centre. Markings round, 4 in 0·01 mm., or compressed, outlines faint but distinct at outer ends of primary rays, rows parallel. Primary rays straight, rows diverging at outer ends. Border indistinct, a narrow hyaline space adjacent to it opposite compartments.

Processes 6, insertion 4/19 of radius from circumference, cylindrical, free ends truncate, no clear space at base.—Pl. V. fig. 1.

Habitat: Newcastle deposit, Barbadoes (Firth!).

A. formosus Arnott, in Pritch. Inf., p. 843.—Diam. 0·21 to 0·325 mm. Surface almost flat at centre, rising slightly to inflations, then steeply upon these, becoming flattened along their crest or sloping slightly down to processes, slope to border gentle. Inflations with sides convex, inner ends sharply defined. Colour lurid, pale grey at centre. Central space rounded or quadrate, 1/28 to 1/30 of diam. broad, punctate. Markings round or polygonal, 3 in 0·01 mm., interspaces punctate, rows in wide curves near inflations. Primary rays with rows diverging on outer 2/3 of length. Border, inner side with granules, outer with striæ, 6 in 0·01 mm., 1/15 to 1/25 of radius broad. Processes 4, insertion 2/5 to 4/13 of radius from circumference, proximal portion smaller than distal, constriction shallow, wide towards base, large but faint, space at base lentelliptical, punctate.—Kitton, Month. Mic. Journ., vol. x. p. 6, pl. xxi.; Sch. Atl., pl. xxxv. figs. 7, 8. *A. Brightwellii* Ralfs, ibid., p. 843; *A. boliviensis* Bréb., *fide* Ralfs, ibid., p. 843.

Affinities to *A. Petersii*, pointed out by Ralfs, remote. First found living by Capt. J. A. Perry, in harbours at Iquique, Pisagua, Islay, and Callao, Peru, at 20 to 32 fms., associated with *A. margaritaceus*, *A. Comberi*, and *A. crux*.

Habitat: Bolivian guano (Greville! Rae! Dickie! Norman! Cleve!); Peruvian guano (Browne! Stokes!); Iquique (Kitton! Hardman!).

A. inflatus Grev., Trans. Mic. Soc. Lond., 1863, p. 69, pl. iv. fig. 12.—Diam. 0·0625 to 0·1375 mm. Surface flat for 1/3 to 4/9 of radius, from its outer edge primary rays rising slightly to processes; inflations with margins distinct and outer ends semicircular. Colour pale grey. Central space quadrate or irregular, 1/18 to 1/27 of diam. broad. Markings round to bluntly angular, 4 in 0·01 mm, decreasing but slightly at border, rows straight, radial. Primary rays with rows in contact only near central space. Border striæ 10 in 0·01 mm., 1/25 to 1/30 of radius broad. Processes 4, rarely 5, insertion 1/3 to 1/5 of radius from circumference, cylindrical, attenuating near base, free ends truncate, clear space at base minute, length about 3 times breadth. Girdle 5/22 of diam. broad with 2 faint parallel lines, height of inflations above girdle 0·01 mm.—Sch. Atl., pl. xcii. fig. 14.

Habitat: Cambridge deposit, Barbadoes (Johnson! Greville! Hardman! Weissflog!); Bridgewater, Barbadoes (Johnson!).

Var. *minor*.—Diam. 0·04 to 0·0525 mm. Surface with central portion extending to about 1/5 of radius. Markings granular, minute, round, rows wider at middle of compartments than near inflations. Primary rays with rows wide and separated to central space. Border striæ 12 to 14 in 0·01 mm. Processes 4, insertion 1/4 to 3/8 of radius from circumference.—Pl. VII. fig. 4.

Habitat: Barbadoes deposit (Johnson!).

Var. *stellata*.—Diam. 0·12 mm. Central space quadrate, 1/32 of diam. broad, inner ends of stellette meeting at its middle. Markings most distinct about outer 2/5 of radius. Central stellette 4-rayed, each ray ovate with narrow end passing through angles of central space, 0·02 mm. long. Border striæ 10 to 12 in 0·01 mm. Processes 4, insertion 1/5 of radius from circumference.—Pl. VII. fig. 3.

Habitat: Cambridge deposit, Barbadoes (Johnson!).

A. mammosus Grev., Trans. Mic. Soc. Lond., 1863, p. 70, pl. iv. fig. 13.—Diam. 0·0775 to 0·16 mm. Surface, central portion flat to 1/3 or 1/4 of radius, outer edge distinct, concave, primary rays rising gradually for 1/2 to 2/3 of length, then more steeply to processes; inflations with distal ends prominent and rounded. Colour pale smoky grey. Central space quadrate, rarely rounded, 1/11 to 1/16 diam. broad, hyaline, rarely with a few granules. Markings polygonal, rounded near central space, 4 in 0·01 mm., rows straight and radial on inflations and at middle of compartments, elsewhere somewhat sigmoid, the greater flexure concave towards primary rays at outer end. Primary rays distinct to central space. Border striæ moniliform, 6 in 0·01 mm., 1/15 to 1/20 of radius broad, inner edge indistinct. Processes 4, insertion 1/5 to 1/7 of radius from circumference, cylindrical, sides convex towards base, free ends convex.—Walker and Chase, New and Rare Diats., p. 4, pl. ii. fig. 11.

The scar of the broken-off process is obovate.

Habitat: Cambridge deposit, Barbadoes (Greville! Johnson!); Newcastle deposit, Barbadoes (Firth!).

Var. *extans*. *A. extans* Grev., Trans. Mic. Soc. Lond., 1864, p. 87, pl. xii. fig. 1.—Diam. 0·215 to 0·32 mm. Surface with primary rays rising more uniformly to processes, but somewhat more steeply in peripheral 1/3, inflations more abrupt. Central space round, clear, about 1/17 of diam. broad. Markings, apiculi most distinct on inflations, sides concave, apices acute. Border striæ 8 in 0·01 mm., 1/24 to 1/25 of radius broad, inner edge distinct. Processes 4 or 5, insertion 1/9 to 1/25 of radius from circumference.

Habitat: Cambridge deposit, Barbadoes (Greville! Johnson!); Newcastle deposit, Barbadoes (Firth!).

A. Janischii Grove & Sturt, Journ. Quek. Mic. Cl., 1887, p. 139, pl. xi. fig. 28. Diam. 0·125 to 0·425 mm. Surface with inflations rising gradually to processes, sharply defined for outer 3/10 to 1/2 of length, at middle of compartments narrow, radial, clear areas distinct. Colour pale to dark grey. Central space elliptical to angular, 1/16 to 1/24 of diam. broad, punctate. Markings polygonal but round towards centre, 3½ to 4 in 0·01 mm., outlines delicate, interspaces punctate, rows in curves round inflations. Primary rays with rows diverging in outer 1/2 of length. Border striæ 10 to 12 in 0·01 mm., 1/50 to 1/85 of radius broad, sometimes with 2 concentric bands of oval granules. Processes 7, rarely 6, insertion 1/6 to 1/9 of radius from circumference, proximal and distal parts subequal, constriction slight.—*A. Janischii* var. *abrupta* Grove & Sturt, ibid., p. 139; *A. in-*

flatus var. *Huttonii*, Grun., Bot. Centralbl., Bd. xxxi. No. 5, p. 133; *A. Huttonii* Grun. in litt.

Habitat: Oamaru deposit, New Zealand (Grove & Sturt! Rae!).

Var. *areolata*.—Diam. 0·26 to 0·4 mm. Surface, outline of central portion less marked, inflations distinct only near outer ends, narrow, radial, clear areas absent. Colour pale grey, smoky grey at border, bluish at outer ends of inflations. Central space round, about 1/26 of diam. broad, at its middle a quadrate punctate spot. Markings rounded towards centre, polygonal with outlines distinct in outer portion, 4 in 0·01 mm., reticulum of irregular meshes well marked on outer 5/13 of compartments. Primary rays with rows diverging in outer 1/3 of length. Border striæ 8 in 0·01 mm., inner edge indistinct. Processes 7, insertion about 1/10 of radius from circumference, cylindrical, free ends truncate, length about twice breadth.

Habitat: Oamaru deposit (Grove! Doeg!).

A. carruthersianus Kitton & Grove, MS.—Diam. 0·185 to 0·2 mm. Surface flat to 2/7 of radius. Primary rays rising gradually from this to their flattened central portion, thence sloping slightly downwards to processes; inflations with outer ends rounded, sides faint; areas between inflations flat at middle with outer edge distinct, convex outwards; slope to border steeper opposite processes and middle of compartments than elsewhere. Colour pale grey. Central space irregularly quadrangular, 1/25 to 1/40 of diam. broad, hyaline. Markings polygonal, 4 in 0·01 mm., rows sometimes curved at inflations. Primary rays with markings muriform, rows diverging slightly near outer ends. Border striæ coarse, 6 in 0·01 mm., sometimes with irregular short protuberances. Processes 4, insertion 1/6 of radius from circumference, hourglass-shaped, clear space at base small.—Pl. V. fig. 7.

Habitat: King George's Sound (Grove! Weissflog!); Newcastle deposit, Barbadoes (Rae!).

A. aucklandicus Grun., Sch. Atl., pl. xli. fig. 3.—Valve rarely elliptical. Diam. 0·07 to 0·155 mm. Surface, central portion flat for 2/7 to 1/4 of radius, with outer edge convex or almost straight across compartments, primary rays on same plane or rising slightly from edge of the central portion to processes, outer ends of inflations merging gradually into peripheral area. Colour dark grey, sometimes bluish at centre. Central space subquadrate or irregular, 1/16 to 1/18 of diam. broad, hyaline or with faint granules. Markings polygonal, 5 in 0·01 mm., without interspaces. Apiculi large, rounded, irregular, most distinct within and near processes, rare on intervening portions of compartments, variable on different inflations of same valve. Primary rays with rows diverging but little but often of different lengths. Border striæ 8 to 10 in 0·01 mm., 1/13 to 1/26 of radius broad. Processes 4, rarely 3 or 5, insertion 2/7 to 3/8 of radius from circumference, proximal portion subelliptical, distal with edges diverging, rarely converging outwards, around each a narrow crescentric line.

The scar of the broken-off process is elliptical.

Habitat: Auckland Islands, New Zealand (Schmidt!); Whangarei, New Zealand (Rae!).

Var. *late-inflata* nov.—Diam. 0·09 to 0·11 mm. Surface with inflations much wider, its edges abrupt. Central space quadrate, 1/19 to 1/38 of diam. broad. Border less distinct on its inner side. Processes 4, insertion 1/3 to 3/8 of radius from circumference.

Habitat: Whangarei, New Zealand (Rae!).

A. Wittii Janisch, in Sch. Atl., pl. cvi. figs. 1, 1*a*.—Diam. 0·365 mm. Surface, inflations low, wide, obovate, with edges distinct but not abrupt. Central space subquadrate, about 1/48 of diam. broad, hyaline, its angles at middle of apices of compartments. Markings polygonal, or rounded close to central space, interspaces absent, rows in wide curves on inflations, secondary oblique rows well-marked. Apiculi few, only around, and chiefly on central side of processes. Primary rays cruciform, rows in contact. Border striæ distinct, 8 in 0·01 mm., about 1/19 to 1/24 of radius broad, its inner edge definite, a narrow sharp line close to inner edge and concentric with it. Processes 4, insertion about 1/3 of radius from circumference, proximal portion rounded minute, distal large, rounded, striated, sometimes with a small terminal knob, clear space at their base, irregular, well-marked.

Habitat: Simoda, Japan (Witt).

A. cinctus Grev. MS.—Diam. 0·08 to 0·14 mm. Surface flat for 1/3 to 3/8 of radius, thence primary rays rising gradually to processes, outer ends of inflations sharply defined. Colour pale grey. Central space 3–4-angled, 1/14 to 1/21 of diam. broad. Markings polygonal, 4 in 0·01 mm., rounded, with narrow clear interspaces about middle of compartments, rows widely curved towards processes. Apiculi round, many, placed irregularly over inflations beyond flat central area, on this area rare, absent from intervening portions of compartments. Primary rays with rows in contact. Border striæ 8 in 0·01 mm., 1/16 to 1/19 of radius broad, inner edge distinct, near outer a dark line, prominent small protuberances with rounded outer ends at its outer edge. Processes 4, insertion 1/4 to 1/5 of radius from circumference, proximal portion longer than distal, constriction well marked, free ends rounded, no clear space at base.—*A. inflatus* Grev., Sch. Atl., pl. xxxv. fig. 9, pl. cvii. fig. 5.

Habitat: Cambridge deposit, Barbadoes (Johnson! Greville! Hardman! Weissflog!); Newcastle deposit, Barbadoes (Firth!).

A. Petersii Ehrb., Mon. Ber. Ak., 1845, p. 361.—Diam. 0·0825 to 0·195 mm. Surface flat for about 1/4 of radius, thence rising along primary rays to process, outer ends of inflations just beyond the processes distinct, compartments within and near zone of processes almost flat; slope to border gentle. Colour pale grey, darker about central space, middle of compartments and processes. Central space quadrate, more rarely triangular, 1/20 to 1/40 of diam. broad, sides opposite ends of primary rays. Markings polygonal, mostly hexa-

gonal, 5 to 6 in 0·01 mm., rows straight only at middle of compartments; apiculi irregular, round, about outer 2/3 of primary rays, absent from central area and intervening areas of compartments. Primary rays with rows diverging slightly in outer half. Border striæ 10 in 0·01 mm., 1/18 to 1/27 of radius broad, a delicate marginal undulation. Processes 4 or 5, insertion 1/3 to 1/5 of radius from circumference, proximal portion smaller than distal, constriction shallow, about 1/3 of length from base, striæ distinct, clear space at base minute, length 1½ to 2 times breadth.—Sch. Atl., pl. xxxv. fig. 4, pl. xli. figs. 1–2. *Eupodiscus Petersii* Kütz., Sp. Alg., p. 135. *E. crucifer*, Shadb., Trans. Mic. Soc. Lond., 1854, p. 16, pl. i. fig. 12.

Habitat: Mouth of Zambesi River, East Africa (Ehrenberg); Algoa Bay guano (Dickie! O'Meara!); Natal (Johnson!); South African guano (Greville! Rae!); Cambridge deposit, Barbadoes (Greville! Hardman!); Newcastle deposit, Barbadoes (Firth!); New Zealand (Johnson! Arnott!); Teneriffe (Greville!); Tamatave (Hardman!); Nankoori (Cleve!).

Var. *asperula*. *A. crucifer* Shadb.? Sch. Atl., pl. xli. fig. 4.—Diam. 0·18 mm. Surface flat to about 2/7 of radius, inflations much larger at outer extremity, equal in breadth to radius, edges straight. Central space irregularly angular, about 1/36 of diam. broad. Markings, apiculi prominent and large about middle of inflations, less evident towards their margins, minute, on a zone of irregular breadth close to border. Border striæ coarser, 8 in 0·01 mm., inner edge sometimes distinct. Processes 4, insertion 1/3 to 1/4 of radius from circumference.—*A. Petersii* Ehrb. according to Grunow and Witt *fide* Schmidt, Atl., pl. cii. fig. 6. The scar of broken-off process is elliptical.

Habitat: Simoda, Japan (Weissflog!).

Var. *notabilis*. *A. Petersii* Ehrb. var.? Sch. Atl., pl. xxxv. figs. 1–3.—Diam. 0·11 to 0·265 mm. Surface, outer edge of central area more concave outwards than in type, inflations rising more steeply, crests flattened near processes, outer ends sometimes reaching border, intervening portions of compartments almost flat from central area for about 3/10 of radius. Central space minute, 1/32 to 1/60 of diam. broad. Markings 6 to 8 in 0·01 mm.; apiculi numerous on central area, inflations fewer and inconspicuous on intervening portions of compartments. Processes 5 to 7, insertion 1/4 to 2/5 of radius from circumference, length about 1¾ times breadth.

Habitat: California (Schmidt! Weissflog! Rae!); Colon and Vera Cruz (Hardman!).

Var. *expansa*.—Valve rarely elliptical, diam. 0·105 to 0·29 mm. Surface with inflations tapering rapidly towards centre, peripheral area flat, its edge convex inwards between inflations. Markings, apiculi minute, continued on inflations to centre, rarely on central space, on intervening portion of compartments confined to an irregular marginal band extending to angles of inflations. Border striæ 8 in 0·01 mm. Processes 4, insertion 1/4 to 1/7 of radius from

circumference, constriction shallow and wide, placed towards base. Pl. VII. fig. 1. Transitional to *A. carruthersianus*.

Habitat: Newcastle deposit, Barbadoes (Firth! Griffin!).

Var. *circumdata*. *A. circumdatus*, Sch. Atl., pl. xxxv. fig. 5.—Small. Surface with inflations sharply defined and rounded at outer ends. Central space quadrate, 1/18 to 1/20 of diam. broad. Markings, apiculi few, distinct, confined to inflations and raised central area. Border, irregular, inner edge defined by a distinct dark line with slight curves between the irregular dark radial lines passing to its outer edge, striæ delicate. Processes 4, insertion about 1/3 of radius from circumference, free ends knob-like, constriction acute.—The scar of broken-off process is obviate.

Habitat: California (Gründler).

Var. *rara*.—Diam. 0·0575 to 0·1025 mm. Surface flat to about 1/3 of radius, inflations less elevated, edges more straight. Markings 8 to 10 in 0·01 mm., apiculi minute on central area, near processes fewer than in type. Processes 4, insertion about 1/4 of radius from circumference.—Pl. VII. fig. 2. The scar of the broken-off process is elliptical.

Habitat: Newcastle deposit, Barbadoes (Weissflog!); Cambridge deposit, Barbadoes (Greville! Johnson!).

A. macraeanus Grev., Trans. Mic. Soc. Lond., 1862, p. 23, pl. ii. fig. 4.—Diam. 0·075 to 0·17 mm. Surface flat to about 1/4 of radius, thence primary rays rising gradually for about 3/5 of length, thereafter flat, or descending slightly to processes; inflations at outer ends merging gradually into peripheral area, a slight depression about middle of each compartment. Colour pale smoky grey. Central space minute, angular, 1/35 to 1/60 of diam. broad. Markings polygonal, 7 to 8 in 0·01 mm., increasing slightly to depressions on compartments, again decreasing to border; apiculi inconspicuous on raised central area, numerous and distinct on inflations and near the border. Primary rays with rows in contact. Border striæ 8 to 10 in 0·10 mm., 1/15 to 1/20 of radius broad. Processes 3 to 5, insertion 1/4 to 2/5 of radius from circumference, hourglass-shaped, constriction median. —Sch. Atl., pl. civ. fig. 2.

The scar of broken-off process is oval and minute.

Habitat: Ceylon (Macrae! Weissflog!); Gazelle Exp. loc. (?) (Weissflog!); Tamatave (Hardman!); sounding off Philippine Islands 705 fms. (Rae!).

A. excavatus Sch. Atl., pl. xxxvi. fig. 10.—Diam. 0·075 to 0·175 mm. Surface flat for about 1/10 of radius, thence primary rays rising to processes, sides of inflations straight or slightly concave outwards, somewhat abrupt, a broad basin-like depression at middle of each compartment, deepest at about 1/3 of radius from border. Colour pale grey, or blue at depressions, dark grey at border. Central space round to quadrate, 1/11 to 1/12 of diam. broad, hyaline. Markings round, 4 to 6 in 0·01 mm., widest at depressions, interspaces hyaline, secondary oblique rows evident on depressions. Primary rays with

rows entire or interrupted, rarely wanting, and replaced by inner ends of contiguous radial rows. Border striæ 8 to 10 in 0·01 mm., 1/15 to 1/30 of radius broad. Processes 3, rarely 4, insertion 1/3 to 3/8 of radius from circumference, oval or rounded, no clear space at base.

Habitat: Simbirsk Polirschiefer (Weissflog!); Sysran deposit, Siberia (Kitton! Grove! Hardman!); Fuur Island, Jutland (Weissflog!).

Var. *apiculata*.—Diam. 0·0875 mm. Surface flat for about 1/7 of radius, sides of inflations merging gradually into intervening areas of compartments, basin-like depressions slight, or absent. Central space round, about 1/7 of diam. broad. Markings, secondary rows on compartments indistinct, apiculi prominent around processes, few. Primary rays irregular, rows wider than in type. Border about 1/18 of radius broad, inner edge indistinct. Processes 3, oval.—Pl. VI. fig. 4.

Habitat: Fuur Island, Jutland (Weissflog).

A. acutus sp. n.—Diam. 0·195 mm. Surface with a wide but shallow depression extending almost from central space to border and to edges of inflations, this depression flat but slightly deepest at the middle of the compartments; inflations distinct, narrow, rising gradually from the central space to the processes. Colour grey, bluish at middle of compartments. Central space round, about 0·0125 mm. broad. Markings rounded closely disposed granules, 8 in 0·01 mm., in interrupted rows arranged in radial fasciculate patches with wide irregular radial interspaces; a narrow subhyaline band at the zone of the processes, outside of this band coarse striæ 8 in 0·01 mm.; on the inflations short oblique crowded rows obvious. Primary rays with the rows sometimes interrupted and widely separated by a hyaline interspace expanding outwards. Border indistinct. Processes 3, symmetrical, insertion about 1/8 of radius from circumference, rounded and knob-like, clear space at their base small.

Habitat: ? (Deby!).*

§ 9. Ornati.

Surface with highest zone at processes, round or angular, well defined. Primary rays inconspicuous.

A. Huttonii Grove & Sturt, Journ. Quek. Mic. Cl., 1887, p. 140, pl. xii. fig. 31.—Diam. 0·0875 to 0·21 mm. Surface flat for 9/14 to 10/17 of radius, highest zone 1/6 to 1/7 of radius broad. Colour grey or bluish to highest zone, dark grey near border. Central space angular, often irregularly quadrate, 1/16 to 1/42 of diam. broad, hyaline or punctate. Markings round or angular, 3 to 3½ in 0·01 mm., interspaces punctate, rows radial, straight. Primary rays sometimes only distinguished towards centre when traced inwards. Border striæ delicate, 1/17 to 1/28 of radius broad. Processes 3 to 6,

* This rare diatom occurs in an *Aulacodiscus* type-plate, by Thum, in the collection of Mr. Julien Deby.

insertion 1/7 to 5/17 of radius from circumference, hourglass-shaped, but proximal portion the larger.

The scar of the broken-off process is oval.

Habitat: Oamaru deposit, New Zealand (Grove & Sturt !).

A. Lahuseni Witt, Simb. Polirsch., p. 20, pl. vi. fig. 9, pl. vii. fig. 5. —Diam. 0·1275 mm. Surface flat to about 17/25 of radius, with outer edge round, passing abruptly into highest zone, the latter about 4/25 of radius broad, slightly convex, its outer edge circular, more abrupt, bearing a narrow ridge with minute undulations; slope to border steep. Colour pale grey. Central space absent. Markings round or bluntly angular, 3½ in 0·01 mm., smaller and more crowded on inner portion of highest zone, at middle of this zone again larger, with more unequal interspaces, interspaces hyaline, widest towards centre, rows radial, straight, interrupted, and not traceable near centre. Primary rays distinct, straight, cruciform, rows interrupted. Border striæ faint, 8 in 0·01 mm., indistinct. Processes 4, insertion about 1/6 of radius from circumference, cylindrical or subinfundibulate, sides concave, in oblique aspect conical, free ends tunicate.—Sch. Atl., pl. ci. fig. 5.

Habitat : Simbirsk Polirschiefer (Witt !).

Var. *marginalis* Witt, ibid., p. 21, pl. vii. fig. 3.—Diam. 0·105 mm. Surface flat to about semiradius, adjoining this a zone rising gently to highest zone, the latter about 1/10 of radius broad, both edges indistinct, circular, slope to border more gradual. Colour more clear, outer part pale grey. Markings on central portion more minute, on adjacent zone moniliform, 6 in 0·01 mm., on highest zone irregular. Primary rays with rows wider, sometimes markings on highest zone are continued across the rays. Border 1/28 of radius broad. Processes 4, insertion 1/4 of radius from circumference.—*A. Lahusenii* var. *marginata*, Sch. Atl., pl. ci. fig. 4.

Habitat: Simbirsk Polirschiefer (Witt !).

Var. *punctata* Witt, ibid., p. 20, pl. vii. fig. 4.—Diam. 0·165 mm. Surface flat to about 8/11 of radius, outer edge less distinct, highest zone about 1/11 of radius broad, outer edge sharply defined, slope to border short, steep. Colour as in var. *marginalis*. Markings round or oval towards centre, towards outer edge of central portion more crowded, 6 in 0·01 mm., at middle of highest zone irregular, elliptical, sometimes granular and minute, rows inconspicuous, but traceable to centre. Primary rays less distinct, rows more regular, not interrupted. Processes 6, insertion 1/7 to 1/8 of radius from circumference.—Sch. Atl., pl. ci. fig. 6.

Habitat: Simbirsk Polirschiefer (Witt !).

Var. *hyalina*.—Diam. 0·1 mm. Surface, central portion flat to about 3/5 of radius and on a plane with border, its outer edge sharply defined, adjacent zone between processes convex, its outer edge less distinct. Markings on central area round, minute, irregular in radial rows, but absent from its outer portion, on adjacent zone closely disposed, submoniliform. Primary rays interrupted by hyaline zone

on central area, but within this traceable to central space. Processes 4, insertion about 1/4 of radius from circumference, with slight median constriction.

Habitat: Sysran deposit (Grove !).

A. Sturtii Kitton, Journ. Quek. Mic. Cl., 1884, p. 17, pl. iv. fig. 1. —Valve sometimes elliptical, diam. 0·085 to 0·21 mm. Surface flat to processes, sometimes slightly elevated around central space, a distinct dark zone, bluntly angular at processes, 1/7 to 1/8 of radius broad, with outer margin less sharply defined than inner, outside of this slope to border gradual. Colour pale grey towards centre, pale blue towards processes, elsewhere dark grey. Central space round to bluntly quadrangular, 1/30 to 1/40 of diam. broad. Markings round or bluntly angular, outlines indistinct, 4 to 5 in 0·01 mm., rows radial to subparallel, slight flexures towards periphery and processes. Primary rays distinct, space between rows narrow. Border indistinct, striæ absent. Processes 3 to 5, insertion 1/5 to 1/7 of radius from circumference, minute, simple, subcylindrical, constriction slight, length about 4 times breadth.—Sch. Atl., pl. cvii. figs. 8, 9.

The scar of the broken-off process is round or elliptical.

Habitat: Japan oysters * (Kitton !); seaweed washings, Japan (Grove !).

A. radiatus† Grev., Trans. Mic. Soc. Lond., 1864, p. 11, pl. i. fig. 4. —Diam. 0·11 mm. Surface flat or rising gradually to about 2/3 of radius, outer edge irregular, distinct; highest zone about 1/7 of radius broad, convex, well marked, round or faintly angular at processes, outer edge abrupt irregular; slope to border gentle. Colour transparent, highest zone dark grey. Central space round to angular, 1/15 of diam. broad, hyaline, or with a few granules. Markings round or compressed, 4 to 5 in 0·01 mm., outlines faint, on highest zone outlines almost inappreciable, but central dots prominent with long axis oblique, and interspaces radially elongated conspicuous, hyaline, with uneven edges. Primary rays inconspicuous, rows separated by a narrow interspace. Border striæ 12 in 0·01 mm., inner edge distinct, 1/22 of diam. broad. Processes 5 or 6, insertion 2/11 of radius from circumference, broken off; clear space at base well marked, with edges uneven.

The scar of the broken-off process is rounded.

Habitat: Cambridge deposit, Barbadoes (Johnson !).

A. pallidus Grev., Trans. Mic. Soc. Lond., 1863, p. 72, pl. v. fig. 17.—Diam. 0·08 mm. Surface flat to about 3/4 of radius, highest zone distinct, pentagonal, 1/8 of radius broad, inflations at processes inappreciable; slope to border gentle. Colour transparent, highest zone pale grey. Central space round, about 1/16 of diam. broad, indistinct, at its centre a small irregular more prominent mark

* These oysters were exhibited at the Colonial Exhibition, and were purchased by Mr. Sturt.

† Not *A. radiatus*, as in Brightwell, Quart. Journ. Micr. Soc., 1860, p. 95, pl. v. figs. 10*a*, 10*b*. See p. 379.

with two opposite sides straight, convergent, the third convex between the closer ends of former, the fourth concave. Markings polygonal, without interspaces, 4 to 5 in 0·01 mm., outlines faint, those on highest zone more distinct, rows straight, radial. Primary rays only recognizable with difficulty when traced inwards from processes. Border indistinct. Processes 10, insertion about 5/16 of radius from circumference, of these 5 are at the angles of the highest zone, the others at a slightly higher level at middle or somewhat towards one side of intervening area. The processes are broken off, leaving a round scar.

Habitat: Cambridge deposit, Barbadoes (Johnson ! Greville !).

§ 10. Retiformes.

Markings small, round or oval, rarely angular, reticulum well marked. Primary rays indistinct.

A. reticulatus Pant., Fossil. Bacil. Ung., p. 60, pl. i. fig. 1.—Diam. 0·25 to 0·275 mm. Surface rising gradually to zone within processes, outer edge of this sharply defined, thence sloping steeply to border. Colour pale grey, reticulum and border darker. Central space angular, 1/27 to 1/33 of diam. broad, punctate. Markings mostly round or oval and oblique, rarely angular, 4 in 0·01 mm., outlines indistinct, rows straight, deflected at processes, beyond highest zone moniliform, interspaces punctate, largest at origin of shorter rows, at outer edge of highest zone a narrow band 1/10 to 1/11 of radius broad, with markings similar to, but inversely more or less crowded than, those on rest of valve ; reticulum with meshes large, irregular, long axis radial, indistinct on outer portion of highest zone, a well-marked single or double band at border with division lines radial. Primary rays inconspicuous, traceable to central space or to more irregularly marked surrounding area. Border striæ 8 to 10 in 0·01 mm., about 1/55 of radius broad, outer edge sometimes inflected at lines of reticulum. Processes (?), insertion about 1/5 of radius from circumference, large, proximal part evanescent, constriction distinct, free ends truncate or slightly emarginate, clear space at base small.—Sch. Atl. pl. cii. fig. 7.

Habitat: Szent Peter and Szakal deposits (Pantocsek !).

A. Grunowii Cleve, Journ. Quek. Mic. Cl., 1885, p. 171, pl. xii. fig. 8.—Diam. 0·14 to 0·315 mm. Surface slightly convex and elevated to about 5/8 of radius, and thence along primary rays to processes, with outer edge concave outwards on compartments, at border flat, in larger valves flat to about 7/19 of radius, thence rising to highest zone, which is about 4/19 of radius broad. Colour grey, raised areas lighter in hue. Central space irregular, indistinct, 1/23 to 1/33 of diam. broad, punctate. Markings round, granular, oval about primary rays and polygonal near border, interspaces unequal, largest towards central space, punctate, rows radial, straight; reticulum with large meshes, less evident outside highest zone, at outer

ends of compartments scale-like, their edges flexuous. Primary rays distinct from inner edge of elevated zone, space between rows wide, diminishing towards processes. Border striæ 8 in 0·01 mm., 1/35 to 1/55 of radius broad, inner edge undulate, formed by rounded outermost meshes of reticulum. Processes 5 to 10, insertion 1/5 to 1/8 of radius from circumference, narrow, constriction median, shallow, wide, free ends rounded, a curved line close to base sometimes distinct, length 2½ times breadth.—Pant., Fossil. Bacil. Ung., p. 58, pl. xi. figs. 93, 95; Sch. Atl., pl. cvii. figs. 1, 2. *A. kinkerianus* E. S. Nott, Walker & Chase, New and Rare Diats., p. 3, pl. i. fig. 9.

Habitat: Brünn Tegel (Cleve! Weissflog!); Kékkö, Szent Peter and Szakal deposits (Pantocsek!).

Var. *subsquamosa* Pant., ibid., p. 58, pl. i. fig. 3; pl. xii. fig. 100.—Diam. 0·16 to 0·27 mm. Surface flat to processes, with edges concave between these, slope to border less steep. Colour pale grey, darker towards border. Central space round or angular, 1/22 to 1/28 of diam. broad. Markings in rows slightly deflected at processes; reticulum indistinct, disappearing towards outer edge of raised area, at border again indistinct. Primary rays undifferentiated on inner half, rarely traceable to central space, space between rows narrow. Processes 9 or 10, insertion 1/6 to 1/7 of radius from circumference.—Sch. Atl., pl. xcii. fig. 1; *A. Grunowii* f. *punctata* Pant., ibid., p. 59, pl. xii. fig. 102.

Habitat: Szent Peter, Szakal and Kékkö deposits (Pantocsek!).

Var. *squamosa* Pant., ibid., p. 59, pl. i. fig. 4.—Diam. 0·11 to 0·115 mm. Surface with slope to border gradual. Central space 1/16 to 1/22 of diam. broad, hyaline or punctate. Markings round, oval, interspaces irregular, rarely polygonal throughout, outlines prominent; reticulum with polygonal irregular meshes more manifest, a single band at periphery with smaller meshes than in var. *subsquamosa*. Primary rays distinct to central space, rows often interrupted. Processes 6 to 9, insertion 1/3 to 2/9 of radius from circumference.

Habitat: Brünn Tegel (Cleve!); Szent Peter and Szakal deposits (Pantocsek!).

A. Rogersii Sch., Atl., pl. cvii. fig. 3.—Diam. 0·095 to 0·22 mm. Surface flat for about 2/5 of radius, thence rising gradually to highest zone just within processes, this zone convex, 1/4 to 1/5 of radius broad, its inner edge circular, indistinct, its outer more manifest, angular at processes, slope to border steep. Colour pale grey, darker towards border. Central space indistinct, angular, 1/25 to 1/32 of diam. broad, reticulate. Markings granular, irregularly round, interspaces wider towards centre, rows inconspicuous within, moniliform outside of processes; reticulum absent from highest zone, elsewhere distinct, around border two concentric bands of meshes more prominent, those on the outer larger and more distinct, within highest zone an indistinct concentric arrangement of meshes recognizable to centre. Primary rays inconspicuous, rarely evident

near central space. Border striæ 10 in 0·01 mm., often punctate 1/24 to 1/28 of radius broad. Processes 3 to 7, insertion 1/4 to 1/6 of radius from circumference, elongated, constriction wide, shallow, or more sharp, free ends knob-like. *Podiscus Rogersi* Bail., Amer. Journ. Sci., 1844, vol. xlvi. p. 137, pl. iii. figs. 1, 2. *Podiscus Rogersii* var. *senaria* Bail., Ehrb. Mon. Ber. Ak., 1844, p. 81. *Podiscus Rogersii* var. *septenaria* Bail., Ehrb., ibid., 1844, p. 81. *Eupodiscus Rogersii* Ehrb., ibid., 1844, p. 81. Sch. Atl., pl. xcii. figs. 2–6. *Eupodiscus Bayleyi* Ehrb., ibid., 1844, p. 81. *Aulacodiscus areolatus* O'Me., Quart. Journ. Mic. Soc., 1878, p. 104.

Podiscus was separated by Bailey from *Tripodiscus* Ehrb., as the number of processes ("feet") varied from 3 to 7. His *P. Rogersi* var. *senaria*, with 6 processes, was accepted by Ehrenberg in 1844 as the true *Eupodiscus Rogersii* Ehrb., his *P. Rogersii* var. *septenaria*, with 7, then becoming *Eupodiscus Bayleyi*. O'Meara's association of *A. areolatus* O'Me. with *Coscinodiscus asteromphalus* from Richmond, Virginia, is erroneous. O'Meara regarded 6 as the prevailing number of processes; in the many specimens I have examined 3, 4, or 5 are more common.

Habitat: Petersburg, Va. (Ehrenberg); New Nottingham deposit (Rae! O'Meara!); Maryland (Cleve! Witt, Griffin!).

A. Argus Sch. Atl., pl. cvii. fig. 4.—Diam. 0·125 to 0·19 mm. Surface flat, sometimes slightly angular at processes, and convex between these, the slope to border steep. Colour dark grey at centre, almost opaque towards border. Central space absent. Markings rounded, granular, in inconspicuous radial rows, most obvious in large valves with wide meshes, mostly a few (3 or 4) at centre, and angles of the smaller meshes, more numerous and along sides of larger; rectículum coarse, meshes sometimes larger for 2/9 to 1/3 of radius from centre,* their walls robust, often strongest at the angles, their surface under reflected light rounded, with delicate finely undulating closely placed lines, the meshes are arranged in radial rows, and within border in several inconspicuous concentric bands. Border indistinct, striæ 8 to 10 in 0·01 mm., 1/25 to 1/40 of radius broad. Processes 3 to 5, insertion 1/3 to 1/5 of radius from circumference, clavate, length 2½ times breadth, no clear space at base.—*Tripodiscus Argus* Ehrb., Abh. Ber. Ak., 1839, p. 159, pl. iii. figs. 6*a–c*; *Tripodiscus germanicus* Ehrb., ibid., 1839, Explan. pl. iii. figs. 6*a–c*; *Tetrapodiscus germanicus* Ehrb., Mon. Ber. Ak., 1843, p. 166; *Pentapodiscus germanicus* Ehrb., ibid., 1843; *Eupodiscus germanicus* Ehrb., Mon. Ber. Ak., 1844, p. 81; *Eupodiscus quater-*

* At centre of valves meshes seen on surface sometimes unite at a slight depth into larger meshes, of which the outlines are in focus at same time as interjacent granules. Cuxhaven specimens belonging to Weissflog, from which the upper layer of valve has been removed, show the transparent lower layer with the processes still attached. This layer has a rounded central space about 1/24 of diam. broad, the markings are round granules, 4 in 0·01 mm., with hyaline interspaces, and are arranged in straight radial rows often disposed in pairs towards the centre, but more crowded towards the border, which bears evident striæ, and now appears sharply defined on its inner side.

narius Ehrb., ibid., 1841, p. 81; *Eupodiscus quinarius* Ehrb., ibid., 1844, p. 81; *Eupodiscus monstruosus* Ehrb., ibid., 1844, p. 81; *Tetrapodiscus monstruosus* Ehrb., ibid., 1844, p. 81; *Eupodiscus Argus* Smith, Syn. Brit. Diat., i. p. 24; Sch. Atl., pl. xcii. figs. 7–11; Van Heurck, Syn. d. Diat. d. Belg., p. 209, pl. cxvii. figs. 3–6; Sch. Atl., pl. xcvii. figs. 7–11; *Eupodiscus americanus* Ehrb., fide Ralfs in Pritch. Inf., p. 843.

Habitat: Richmond, Va., Petersburg, Va., Piscataway, Md. (Ehrenberg); Patagonian guano (Janisch); Cuxhaven, Glückstadt, Hamburg (Ehrenberg); Thames near Gravesend (Poulton, Roper); near Faversham (Shadbolt); Isle of Dogs (Roper); River Orwell near Ipswich (Hodgson); Medway (Dallas); coast of France (de Brébisson); coast of Holland (Suringar); coast of Denmark (Heiberg); Charleston Harbour, N. America (Bailey); Ascidia, Hull (Greville! Gregory); Ascidia off Flamborough Head (Norman!); stomach of oysters, Humber (Dickie!); stomach of mussel (loc.?) (Dickie!); *Noctiluca miliaris* (Baddeley).

A. Thumii Sch. Atl., pl. cii. fig. 8.—Diam. 0·185 mm. Surface flat to, and slightly angular at, zone of processes; slope to border gentle. Colour dark grey, becoming almost opaque about zone of processes. Central space indistinct. Markings round or oval and oblique granules, most brilliant in the meshes of the reticulum, moniliform towards border, in radial rows that are indistinct between centre and semiradius; interspaces irregular, most evident towards the centre. Reticulum evident, the meshes rounded, a single band at border, with much larger meshes separated by stronger radial lines. Primary rays evident, the rows diverging but slightly at outer ends. Border well marked, striæ 8 in 0·01 mm., about 1/12 of radius broad, outer edge sometimes irregular. Processes 5 or 6, large, insertion 1/4 to 1/5 of radius from circumference, proximal portion with sides convex, converging outwards, distal subcylindrical, constriction slight, free ends convex, length 2 to 3 times greatest breadth, clear space at base evident.

Habitat: Sta. Monica deposit (Thum!).

§ 11. Blanditi.

Inflations sometimes distinct. Markings polygonal. Primary rays well marked.

(*a*) Processes small.

A. concinnus Kitton MS.—Diam. 0·1 to 0·1075 mm. Surface flat for about 5/8 of radius, with outer edge indistinct, slope to border gradual, sometimes slightly convex at centre. Colour blue to somewhat beyond semiradius, beyond this smoky grey. Central space minute, angular, 1/40 to 1/43 of diam. broad. Markings subequal on central portion, 6 in 0·01 mm., decreasing gradually to border, sometimes largest on median zone, rows radial, straight, secondary oblique rows inconspicuous. Primary rays 4, cruciform, distinct,

rows diverging slightly at outer ends. Border striæ delicate, 14 in 0·01 mm. Processes 4, insertion 1/4 to 3/11 of radius from circumference, clear space at base absent.—Pl. V. fig. 4.

The scar of the broken-off process is elongately elliptical.

Habitat: Sysran deposit, Russia (Kitton!).

A. prominens Kitton MS.—Diam. 0·0875 mm. Surface with central area much elevated, quadrate, angles extending to processes, outer edges with a slight concavity about middle of compartments; slope to border steep. Colour bluish at centre, elsewhere smoky grey. Central space rounded, about 1/35 of diam. broad, clear. Markings 5 to 6 in 0·01 mm., rows slightly deflected at processes, secondary oblique rows indistinct. Primary rays manifest, cruciform, rows diverging slightly in outer 1/3 of length. Border striæ 8 in 0·01 mm., about 1/23 of radius broad, inner edge indistinct. Processes 4, insertion about 6/17 of radius from circumference, hourglass-shaped, constriction median, wide, free ends protuberant, clear space at base small.—Pl. V. fig. 5.

Habitat: Sysran deposit, Russia (Kitton!).

A. Kittoni Arnott, in Pritch. Inf., p. 844, pl. viii. fig. 24.—Diam. 0·0625 to 0·23 mm. Surface flat for about 1/3 of radius, with outer edge faint and concave between primary rays, the rays often rising somewhat to processes, slope to border gentle. Colour pale brownish or smoky grey, rarely clear throughout. Centre with distinct rosette, 1/12 to 1/23 of diam. broad, rarely inconspicuous. Markings 4½ to 5 in 0·01 mm., without interspaces, rows straight or slightly sigmoid with sharper curve towards periphery, secondary oblique rows distinct. Primary rays well marked, sometimes interrupted towards centre. Border striæ 4 to 5 in 0·01 mm., 1/24 to 1/40 of radius broad. Processes 4 to 8, rarely 3, 2, 1, or 0; insertion about 1/6 of radius from circumference; a long, straight, tapering mark opposite primary rays, with two transverse or oblique rounded lobes at its outer end and a broad crescentic band on peripheral side; in girdle aspect mammiform, with a clear apical portion protruding at sides and on peripheral but not on central aspect. Girdle 0·025 mm. wide on valve 0·13 mm. in diam., with faint parallel lines.—Sch. Atl., pl. xxxvi. figs. 5–7; pl. xli. fig. 6. *A. lævis* Brightw., Quart. Journ. Mic. Soc., 1860, p. 95, pl. vi. fig. 13. *A. Ehrenbergii* Janisch., Abh. Sch. Ges. väter. Cult., 1861, p. 162, pl. ii. fig. 6; Sch. Atl., pl. xxxvi. figs. 3, 4. *A. Brightwellii* Janisch, ibid., 1861, p. 162, pl. ii. fig. 7; Sch. Atl., pl. xxxvi. figs. 8, 9. *A. deformis* (Habirsh. Cat. Diat. § *Aulacodiscus*) is, according to Habirshaw, equivalent to *Eupodiscus deformis*, and is a var. of *A. Kittoni*.

Habitat: Peruvian guano (Greville! Weissflog! Rae! Hardman! Harrison); Monterey stone (Gregory, Kitton, Ralfs, Cleve!) Sta. Monica deposit (Rae! Kinker!); Islay, Peru (Kitton, Hardman!); "New Zealand" (Johnson!); Bay of Islands, New Zealand (Hardman!); San Francisco (Witt); sea foam, Sta. Cruz, California (H. L. Smith, Weissflog!); marine algæ, California (Rae!); Monterey sea-

weed (Norman!); west coast South America (Kinker!); Houanillas (Kinker!).

Var. *Johnsonii*. *A. Johnsonii* Arnott, in Pritch. Inf., p. 844. —Diam. 0·05 to 0·125. Surface flat to processes. Colour light grey to transparent. Central space round or angular, 1/20 to 1/25 of diam. broad. Markings polygonal, 4 in 0·01 mm. Outlines more delicate, secondary rows less distinct. Border striæ 6 to 10 in 0·01 mm., 1/20 to 1/25 of radius broad. Processes 4, insertion 1/4 to 1/5 of radius from circumference, proximal portion semicircular, distal clavate; at base a delicate, rounded, obliquely placed lobe on corresponding side of all the processes; the crescentic line distinctly angular.

Habitat: S. African guano (Greville!); Nankoori deposit (Gray!); Cambridge deposit, Barbadoes, Algoa Bay, and Sumatra (Hardman!); Nicobar (Weissflog!); Sierra Leone (Leuduger-Fortmorel, Cleve!).

Var. *africana*. *A. africanus* Cottam, Journ. Quek. Mic. Cl., 1876, p. 149, pl. xii. figs. 1, 2, 3, 8.—Diam. 0·0625 to 0·1125 mm. Surface rising slightly to processes. Central rosette 1/12 to 1/15 of diam. broad. Markings with still fainter outlines, 4 to 5 in 0·01 mm. Border about 1/45 of radius broad. Processes 4 or 5, rarely 2, 3, 6, or 0; insertion 1/4 to 1/6 of radius from circumference, proximal portion flask-shaped, with a small cylindrical portion at outer end whence a long delicate mark proceeds inwards, external crescentic line forming a uniform arc; in girdle aspect curving outwards, and concave on outer side, sigmoid towards centre. Girdle 0·0225 mm. wide, in frustule 0·079 mm. in diam., with four faint parallel lines.—*A. Johnsonii* Arnott, Sch. Atl., pl. xxxvi. figs. 1, 2; pl. xli. figs. 7–10; pl. civ. fig. 1. Hauck & Richter, Phykothek. Univ., 1887, No. 150.

Habitat: Banana Creek, Congo River, W. Coast Africa (Cottam! Macrae! &c.); Nukahiva sand, Marquesas (Kitton! Weissflog! Cleve).

(β) Processes large.

A. Rattrayii Grove & Sturt, Journ. Quek. Mic. Cl., 1887, p. 139, pl. xi. fig. 29.—Diam. 0·075 to 0·235 mm. Surface almost flat for 1/2 to 5/7 of radius, its outer edge angular just within processes, convex between these; slope to border steep. Colour pale lurid to pale grey, darker between processes. Central space 3–4-angled, 1/30 to 1/47 of diam. broad, hyaline. Markings 4 in 0·01 mm., outlines distinct, subpearly, rows straight radial, at sides of processes areolæ oblique. Primary rays distinct, rows in contact or diverging slightly at outer ends. Border striæ punctate, 10 to 12 in 0·01 mm., secondary oblique rows distinct, 1/13 to 1/15 of radius broad. Processes 2 to 4, insertion 2/5 to 2/9 of radius from circumference, proximal portion evanescent, distal knob-like, constriction well marked, free ends rounded, clear space at base distinct, length 1½ to 3 times breadth. In girdle aspect height of centre 0·0225 mm., processes truncate.—

A. Beeveriæ Johnson, Grove & Sturt, ibid., p. 9. *A. Comberi* var. *oamaruensis* Grove & Sturt, ibid., p. 140.

Habitat: Oamaru deposit (Grove & Sturt! Bucknal!).

Var. *convexa*. *A. convexus* Grove & Sturt, ibid., p. 140, pl. xii. fig. 32.—Valve elliptical. Diam. 0·0875 to 0·09 mm. Surface flat to about 1/4 to 2/3 of radius. Colour pale bluish at centre. Central space 1/36 to 1/40 of diam. broad, sometimes replaced by a faint rosette. Processes 3, insertion about 1/3 to 1/5 of radius from circumference, length about $1\frac{7}{8}$ breadth, clear space at base minute.

Habitat: Oamaru deposit (Grove & Sturt!).

A. sollittianus Norman, Trans. Mic. Soc. Lond., 1861, p. 7, pl. ii. fig. 5.—Diam. 0·0825 to 0·22 mm. Surface depressed at centre, rising to highest zone just within processes, this zone angular at processes, sides concave, slope to border gentle, rarely showing several (5) angular zones. Colour pale grey, darker at middle of compartments and at outer edge of highest zone. Central space round, 1/90 of diam. broad, hyaline, with rosette round or angular, 1/18 to 1/20 of diam. broad. Markings 4 in 0·01 mm., central dot faint, interspaces absent, rows curved around processes, hence at centre of periphery of compartments a V-shaped area frequent, secondary oblique rows distinct. Primary rays with markings increasing in outer half. Border striæ 4 to 6 in 0·01 mm., about 1/30 of radius broad. Processes 4 to 6, insertion 1/3 to 1/4 of radius from circumference, large, irregularly hourglass-shaped, proximal portion smaller than distal, constriction towards base, free ends rounded, length about twice greatest breadth, clear space at base large.—Sch. Atl., pl. xxxiii. figs. 11, 13; pl. cii. fig. 5; pl. ciii. fig. 3.

Habitat: Nottingham deposit (Norman, Hardman! O'Meara! Cleve).

Var. *nova-zealandica* Grove & Sturt, Journ. Quek. Mic. Cl., 1887, p. 9, pl. iii. fig. 10.—Diam. 0·125 to 0·225 mm. Surface highest and slightly convex at centre, median area uniformly depressed, its angles rounded close to border, periphery flat. Central space minute, no rosette. Markings $4\frac{1}{2}$ to 5 in 0·01 mm., on inner portion small apiculi sometimes present. Primary rays with markings equal or decreasing on outer half to processes. Border striæ 10 to 12 in 0·01 mm., 1/12 to 1/21 of radius broad, secondary oblique lines distinct. Processes 3, insertion 2/5 to 3/8 of radius from circumference, larger distal portion rounded, 2 to $2\frac{1}{2}$ times as broad as proximal, constriction deep.

Habitat: Oamaru deposit (Grove & Sturt!).

Var. *protuberans*.—Diam. 0·2 mm. Surface with low inflations about outer ends of primary rays, outer edge of highest zone concave between processes, abrupt, a flat level elliptical area at outer end of each compartment. Central rosette 1/20 of diam. broad. Markings, apiculi numerous. Primary rays with markings increasing still more towards processes. Processes 6, insertion 1/4 of radius from circumference, smaller, constriction submedian, length about twice breadth.

Habitat: Sta. Barbara deposit (Rae!).

Var. *jütlandica*. *A. jütlandicus* Kitton, Journ. Queck. Mic. Cl., 1885, p. 168, pl. xiii. fig. 3.—Diam. 0·1175 mm. Surface flat to about 1/6 of radius, thence primary rays continued on same plane to processes, inflations at outer ends low, wide. Central space rounded, about 1/23 diam. broad. Markings 6 to 8 in 0·01 mm., secondary oblique rows distinct around processes. Processes 4, insertion about 1/3 of radius from circumference, small hourglass-shaped, proximal portion somewhat smaller than distal.—Sch. Atl., p. xli. fig. 5. *A. crux* var. *glacialis* Grun., Denk. Wien. Ak., 1884, p. 69, pl. ii. (B), fig. 62. Sch. Atl., pl. xli. fig. 5.

Habitat: Fuur, Jutland (Kitton! Weissflog!).

§ 12 Speciosi.

Surface highest at centre. Markings sometimes pearly, rows radial, subradial or parallel, interspaces hyaline. Primary rays distinct, rarely inconspicuous, sometimes slightly elevated above level of adjoining area.

A. neglectus sp. n.—Diam. 0·2 mm. Surface flat to about semiradius, thence slope to border gradual, primary rays on a level with adjacent areas. Colour pale to slaty grey. Central space irregularly quadrangular, punctate, about 1/24 of diam. broad. Markings mostly quadrate, in contact, 4 in 0·01 mm., somewhat pearly, interspaces at origin of shorter rows or as interuptions in course of longer rows, rows deflected slightly at processes, moniliform at border, secondary regular concentric bands distinct to zone of processes. Primary rays inconspicuous, rows diverging a little at their outer ends. Border striæ 12 in 0·01 mm., about 1/40 of radius broad, a dark line at its middle or inner third, outside of this striæ more faint. Processes 12, insertion about 1/7 of radius from circumference, proximal portion wider than more cylindrical distal, constriction slight, free ends convex, length $2\frac{1}{2}$ times breadth.—Pl. VI. fig. 1. At edge of scar of broken-off processes there is a circlet of minute puncta.

Habitat: Sta. Monica deposit (Rae!).

A. umbonatus Grev., Trans. Mic. Soc. Lond., 1864, p. 9, pl. i. fig. 2.—Diam. 0·095 mm. Surface, central portion flat to about semiradius with outer edge rounded abrupt, adjacent area on compartments also flat, slope to border steep, primary rays somewhat above level of adjoining areas. Colour pale grey, darker about elevated area. Central space angular, 1/19 of diam. broad, punctate. Markings subquadrate, 4 in 0·01 mm., without interspaces, more irregular on raised central area, decreasing irregularly outside zone of processes, rows straight parallel, secondary almost straight rows parallel to each other, and to a tangent to circumference at middle of compartments. Primary rays distinct, rows diverging widely in a V-shaped manner on outer 1/3 of length, prolonged past processes to border. Border granules 8 in 0·01 mm. Processes 7, insertion about 1/5 of radius from circumference.

The scar of broken-off process is large and irregularly oval.

Habitat: Cambridge deposit, Barbadoes (Johnson! Norman!).

Var. *dirupta* Grove & Sturt M.S.—Diam. 0·035 mm. Surface flat from centre to border, primary rays not elevated. Colour smoky grey, darker at border. Central space about 1/14 of diam. broad. Markings quadrate, 3½ to 4 in 0·01 mm., rows sometimes subradial, moniliform at border. Primary rays distinct, rows diverging widely almost from central space. Border with inner edge indistinct. Processes 6, insertion about 1/7 of radius from circumference.—Pl. VI. fig. 9.

The scar of broken-off process is minute, oval.

Habitat: Oamaru deposit (Grove!).

A. lucidus sp. n.—Diam. 0·1135 to 0·175 mm. Surface flat for 2/7 to 1/2 of radius, primary rays slightly elevated, compartments with a wide flat portion at border. Colour light grey. Central space minute, about 1/65 of diam. broad. Markings polygonal, 4 in 0·01 mm., rows radial, in wide curves towards and around processes. Primary rays distinct, rows with markings larger in outer than in inner half, diverging but slightly at outer ends. Border striæ irregular, 5 to 8 in 0·01 mm., inner edge irregular. Processes 8, insertion about 1/4 to 1/5 of radius from circumference, proximal portion smaller than round knob-like distal; clear space at base absent.—Pl. V. fig. 3.

Habitat: Barbadoes deposit (Hanwell! Grove!).

A. coronatus Grove MS.—Diam. 0·0925 mm. Surface flat for about 1/4 of radius, thence sloping slightly to zone of processes, almost flat around border. Primary rays on a level with adjacent areas. Colour subhyaline, darker at centre and processes. Central space indistinct. Markings polygonal, 5 in 0·01 mm. on central portion, 8 to 10 in 0·01 mm. from zone of processes to border, without interspaces; rows straight, radial. Primary rays inconspicuous, the rows in contact. Border indistinct, about 1/19 of radius broad. Processes 9, 11/19 of radius from circumference, proximal portion small, distal knob-like; clear space at their base large.

Habitat: Jackson's Paddock, Oamaru (W. J. Gray!).

I am unacquainted with "Aulacodiscus californicus Bail. Coll." recorded by Habirshaw in the second edition of his Catalogue. The name is only recorded here, and remains a *nomen nudum*.

Auliscus sculptus Ralfs and *Eupodiscus radiatus* Bail. were in error printed in Brightwell's paper (Quart. Journ. Mic. Soc., 1860, p. 94) as species of *Aulacodiscus*, but the errors were corrected in the errata on p. 139 of the same volume.

The valve from the Barbadoes deposit, placed doubtfully by Greville in *Aulacodiscus* as *A (?) paradoxus* (Trans. Mic. Soc. Lond. 1863, p. 72, pl. v. fig. 18), was subsequently referred by him to *Omphalopelta*, and recorded as such in the copy of his memoir in the possession of Mr. Kitton. It is really a species of the genus *Actinoptychus*.

Artificial Key.

1.	Outline polygonal	*polygonus.*
	„ circular	2
2.	Processes absent	3
	„ present	4
3.	Primary rays indistinct, markings round, interspaces hyaline	*suspectus.*
	„ „ distinct, markings polygonal, in contact	*apedicellatus.*
4.	A prominent broad crescentic band on peripheral side of processes	*Kittoni.*
	No such band	5
5.	Surface flat to border	6
	„ „ to zone of processes	7
	„ „ from centre for a portion of radius within zone of processes, centre not depressed	8
	„ depressed at centre	9
6.	A hyaline band at outer edge of central space with short extensions into apices of compartments; markings unresolved	*exiguus.*
	No such band; markings polygonal, minute but larger, clear area at base of processes large	*barbadensis.*
7.	Reticulum coarse, meshes radial, primary rays undifferentiated; opaque	*Argus.*
	Meshes within processes large, rounded, outermost band much larger than the others, with division lines radial. Markings more distinct, frequently oval and oblique	*Thumii.*
	No reticulum	10
10.	Apiculate; primary rays distinct; processes hourglass-shaped, clear space at their base minute	*scaber.*
	Non-apiculate	11
11.	A dark band at zone of processes more sharply defined on inner than on outer side; primary rays distinct; processes small, subcylindrical, clear space at their base absent	*Sturtii.*
	No such band	12
12.	Markings concentric	*Browneii.*
	„ non-concentric	13
13.	Markings rounded with punctate interspaces	14
	„ round, granular, interspaces hyaline; central space absent; striated border wide; processes numerous (14)	*minutus.*
	„ polygonal, without interspaces	15
14.	Processes large, faint space at base punctate; lurid	*Comberi.*
	„ with space at base semicircular, hyaline; valve transparent, edge of central area somewhat concave between processes	*hyalinus.*
	„ minute, space at their base absent	*Beeveriæ.*
15.	Processes minute, subclavate, clear space at their base absent ..	*elegans.*
	„ larger, subcylindrical, free ends truncate, space at their base small	*compactus.*
	„ large, with median constriction, and free ends rounded; border hyaline	*parvulus.*
	„ small, constriction wide, median, clear space at their base small, outline of central portion of valve concave outwards between processes	*prominens.*
8.	A basin-like deep depression at middle of compartments	*excavatus.*
	Depression wide, shallow; markings in interrupted rows arranged in radial fasciculate patches with wide irregular hyaline radial interspaces	*acutus.*
	A clear angular zone a short distance within processes	*patens.*
	No such depression or clear zone	16
16.	Without large cuneate inflations	17
	Such inflations present	18
17.	Processes large, proximal portion much smaller than distal, inserted far in on valve, clear space at their base large, border striæ punctate	*Rattrayii.*

	Processes small or minute	19
19.	Markings quadrate, pearly, concentric on elevated area	*neglectus.*
	„ non-concentric	20
20.	Markings rounded with brown central dot, rows on compartments parallel	*pulcher.*
	„ rounded in wide rows with hyaline interspaces, towards centre polygonal	*dispersus.*
	„ angular, rows parallel, primary rays with rows diverging widely at outer ends	*umbonatus.*
	„ polygonal, not pearly, processes with proximal portion smaller than distal, primary rays diverging but slightly	*lucidus.*
	„ pologonal, not pearly, processes placed near the semiradius with large clear space at their base, central space indistinct	*coronatus.*
	„ in radial rows or irregular	21
21.	Markings on elevated portion large, round, irregularly placed, outside of this much smaller and radial; processes with wide shallow constriction	*probabilis.*
	„ more equal; primary rays distinct	22
22.	Markings round, interspaces hyaline; processes with sharp median constriction	*simplex.*
	„ polygonal, without interspaces	23
23.	Markings small (6 in 0·01 mm.); primary rays cruciform; processes with free ends protuberant	*concinnus.*
	Markings larger (4 in 0·01 mm.); processes clavate, free ends simply rounded	*radiosus.*
	Markings still larger (2 to 3 in 0·01 mm.); processes with sharp median constriction, and no clear space at their base	*cellulosus.*
18.	Inflations wide, cuneate, sides convex, inner ends sharply circumscribed	*formosus.*
	Inflations with inner ends merging into raised central area ..	24
24.	Inflations rising gently on inner portion, steeply near processes	*mammosus.*
	„ more uniform	25
25.	Rows parallel on compartments, valves transparent	*gracilis.*
	„ radial	26
26.	Primary rays on a level with central area, cruciform, more conspicuous than rest of valve, sides of inflations indistinct	*quadrans.*
	Primary rays rising slightly outwards	27
27.	Inflations long, sides convex, more conspicuous in outer portion where the oblique markings are distinct	*Janischii.*
	Inflations with sides more straight, the oblique markings less obvious	28
28.	Markings rounded, processes narrow, cylindrical	*inflatus.*
	„ polygonal, processes with a constriction	29
29.	Non-apiculate	*carruthersianus.*
	Apiculate	30
30.	Outer ends of inflations sharply defined	31
	„ „ merging gradually into peripheral area	32
31.	Proximal portion of processes larger than distal, markings subpearly, protuberances on border large	*cinctus.*
	Proximal portion of processes much smaller than distal, markings more delicate	*Petersii.*
32.	A distinctly defined broad apiculate zone at border, apiculi on inflations small	*macraeanus.*
	No such zone, apiculi on inflations large	*aucklandicus.*
	„ „ „ „ few, minute	*Wittii.*
9.	Non-crateriform	33
	Crateriform	34
33.	A prominent deeply serrated ridge on zone of, and between processes	*Lahuseni.*
	No such ridge	35
35.	A large, distinctly defined, elliptical or triangular, finely areolate central area	36
	No such area	37

36. Primary rays short, V-shaped, markings small .. .. *septus.*
„ „ obsolete, markings larger and more pearly .. .. *Schmidtii.*
37. A reticulum 38
No reticulum 39
38. Meshes large, unequal, often imperfect, with one distinct band at border, markings mostly oval and oblique .. .. .. *reticulatus.*
Markings round 40
40. Meshes smaller, subregular, in concentric bands, a few bands at border well defined, absent from most elevated zone .. *Rogersii.*
Meshes most evident and scale-like on flat peripheral portions of compartments .. .. *Grunowii.*
39. Inflations absent or slight 41
„ present, low, mammillate beneath processes 42
41. Process large, proximal portion much smaller than distal, clear space at base well marked; a central rosette .. .. .. *sollittianus.*
No rosette 43
43. A sharply defined polygonal area from centre to processes, its outer edge steep and sides straight across compartments .. *secedens.*
Markings large, brilliant, with distinct central or unilateral dot, processes with well-marked clear space at their base .. *margaritaceus.*
Markings smaller, less brilliant, the rows at middle of compartments together forming an inconspicuous cross; primary rays cruciform with slight inflations at outer ends; processes small, with clear space at base minute .. .. .. *crux.*
Most elevated zone at processes narrow angular 44
44. With prominent, hyaline, irregular, radial spaces on most elevated zone .. .. *radiatus.*
No such spaces 45
45. Marking round, large, distinct .. .. *Huttonii.*
„ polygonal, small, indistinct, valve transparent .. .. *pallidus.*
42. Processes long, narrow, cylindrical .. .. *amœnus.*
„ conical, large, outer edge of sculptured area undulate *intumescens.*
„ with lateral median constriction 46
46. Markings in regular concentric bands .. .. *orientalis.*
No such bands 47
47. Markings in irregular angular subconcentric bands towards central space; primary rays indistinct .. .. *affinis.*
No such bands; primary rays well-marked, more opaque .. *oregonus.*
34. Primary rays on a level with adjoining surface .. .. *kilkellyanus.*
„ „ raised on inflations 48
48. A distinct lobe at sides of outer ends of inflations .. .. .. *rotulus.*
No such lobes 49
49. Conspicuous bent subradial or oblique irregular interspaces on outer portion of valve; outer ends of inflations bounded by prominent dark curved lines .. .. *anthoides.*
No such interspaces 50
50. Coralloid markings on sides of inflations .. .. *grevilleanus.*
No such markings 51
51. Most elevated zone sharply defined, narrow angular 52
„ „ less sharply defined, sometimes wide .. 53
52. A reticulum evident .. .. *superbus.*
„ just visible .. .. *attenuatus.*
No reticulum, irregular ridges on inflations .. .. *archangelskianus.*
53. Processes with proximal portion rounded, distal cylindrical .. *spectabilis.*
„ biconvex on each side 54
54. Slope of primary rays from highest zone to processes steep; interspaces punctate .. .. *angulatus.*
Slope of primary rays from highest zone to processes gentle; interspaces hyaline .. .. *decorus.*

VII.—*The Foraminifera of the Red Chalk.*

By H. W. Burrows, C. Davies Sherborn, and Rev. G. Bailey.

(*Read 9th May*, 1888.)

In 1859 the Rev. Prof. Wiltshire in a paper "On the Red Chalk of England,"* read before the Geologists' Association, quoted and figured (pl. ii. fig. 8) one species of Foraminifer (*Cristellaria rotulata* d'Orb.) as occuring in the red chalk of Speeton. In the following year Major-General Emmett in "Notes on the Red and White Chalk of Yorkshire,"† gave, on the authority of Messrs. W. K. Parker and T. R. Jones, the following species:—*Globigerina bulloides, Textularia pygmæa, Rotalia ammonoides, Dentalina communis, Cristellaria rotulata.*

Professor Blake,‡ speaking of the chalk of Yorkshire, mentions the occurrence of minute hollow spheres, but says that he has "not been able definitely to find any apertures in them, otherwise they look like the *Orbulina universa*, abounding to the extinction of all other Foraminifera." Parker and Jones in Emmett's note above mentioned had noticed this also in the red chalk, and suggested the minute chambers were "separate cells of *Globigerina* and *Dentalina*, the former predominating."

The Mem. Geol. Survey published in 1880 on "The Geology of Scarborough" mentioned *Cristellaria rotulata* Lam. as occurring in the red chalk of Speeton.

Mr. Whitaker in the list of fossils of the red chalk,§ quoted two species from the Hunstanton red chalk, *Cristellaria rotulata* Lam., and *Globigerina cretacea* d'Orb.

Thus up to date only *six* species of Foraminifera have been noted from the red chalk of England.

For some years we have been working independently on this subject, and the combined result shows an important addition to the previously recorded species. These will form the subject of a joint paper to be issued shortly, and for which the drawings are already prepared.

The following is a provisional list of the forms in our collections already determined, a number of somewhat obscure specimens remaining to be finally examined.

Spiroloculina, 2 spp.
Miliolina spp.
Trochammina cretacea ? Reuss.
„ gordialis P. & J.
„ incerta d'Orb.

* 8vo, London, 1859.
† Geologist, 1860, pp. 419–20.
‡ Proc. Geol. Assoc., v. (1877) p. 266.
§ Proc. Norwich Geol. Soc., i. pt. vii. (1883).

Textularia agglutinans d'Orb.
„ (Proroporus) complanata Reuss.
„ pygmæa Reuss fide P. & J.
„ trochus d'Orb.
„ turris d'Orb.
Verneuilina, 2 spp.
Spiroplecta biformis P. & J.
Gaudryina sp.
Bulimina affinis d'Orb.
„ Presli Reuss.
Bolivina textularioides Reuss.
„ sp.
Pleurostomella alternans Schw.
„ subnodosa Reuss.
Lagena apiculata Reuss.
„ „ (var.).
„ aspera Reuss.
„ globosa Montf.
„ lævis Montf.
„ marginata W. & B.
„ cincta Seg.
„ 2 spp.
Nodosaria (Glandulina) lævigata, d'Orb.
„ „ obtusissima Reuss.
„ radicula Linn.
„ calomorpha Reuss.
„ limbata d'Orb.
„ longiscata d'Orb.
„ obscura? Reuss.
„ oligostegia Reuss.
„ prismatica Reuss.
Nodosaria (Dentalina) abnormis Reuss.
„ „ brevis d'Orb.
„ „ communis d'Orb.
„ „ soluta Reuss.
Lingulina carinata d'Orb.
Frondicularia Archiaciana d'Orb.
„ biformis Marsson.
„ gaultina Reuss.
Rhabdogonium tricarinatum d'Orb.
Vaginulina arguta Reuss.
„ eurynota Reuss.
„ recta Reuss.
„ legumen Linn.
Cristellaria crepidula F. & M.
„ cultrata Montf.
„ gibba d'Orb.
„ Marckii Reuss.

Cristellaria rotulata Lam.
„ 4 spp.
Polymorphina amygdaloides Reuss.
„ gibba d'Orb.
„ horrida Reuss.
„ lactea W. & J. (elongate var.).
Uvigerina sp.
Ramulina aculeata d'Orb.
Globigerina bulloides d'Orb.
„ „ (var.)
„ cretacea d'Orb.
„ Linnæana d'Orb.
Orbulina universa d'Orb.
Planorbulina ammonoides Reuss.
Truncatulina sp.
Pulvinulina Menardii d'Orb.
Discorbina, 2 spp.
Nonionina sp.
Polystomella macella F. & M.
„ subnodosa Münst.

By far the greater number of the above-named species are of comparatively large size, and come from Speeton; a table showing distribution will be given in the paper.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Spermatogenesis of Marsupials.‡—Dr. C. M. Fürst has had the rare opportunity of studying the spermatogenesis of marsupials. The testes which he has sectioned were those of *Metachirus quica* and *Phascogale albipes*. His chief results are as follows:—

The seminal canals contain two main forms of cell—the seminal and the marginal cells. The latter have no direct rôle in spermatogenesis. The former exhibit three stages—(*a*) the primitive cells (S^2) (Samenstammzellen), which give origin by division to (*b*) the sperm-mother-cells (S^1) (Samenmutterzellen), which divide by karyokinesis to form (*c*) the sperm-daughter-cells (Samentochterzellen (S^0), which give off a polar body and form spermatozoa (S). The first are peripheral, the second move centrewards, the third are median and central. The cells and spermatozoa lie in tiers and rows, each of which exhibits cells of the same stage. Development proceeds from the periphery inwards, and a complete series may be observed in successful sections. In the sperm-daughter-cells (S^0) the nucleus undergoes polar differentiation, a cap is formed, a polar body is extruded at the tail end (opposite to the cap), then maturation proceeds apace.

The nucleus elongates and grows. The diffusely stained contents exhibit well-defined chromatin-granules. These aggregate along with adjacent achromatin and are drawn to the cap. The nuclear membrane is invaginated. The chromatin is disposed at the cap and tail poles. The cap becomes flat and is finally thrown off. The chromatin nuclear substance, continuous with that of the head, is prolonged in a fine thread at the tail end. The cellular substance is lost. Nuclear substance alone is left; a spiral thread occurs only provisionally. The sperm consists of

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Arch. f. Mikr. Anat., xxx. (1887) pp. 336-65 (3 pls.).

a chromatin portion forming head and axial filament. This is uncovered on the upper surface of the head, but enveloped further down, and in the tail by an achromatin or parachromatin sheath.

First Branchial Cleft of Chick.*—Mr. F. P. Mall finds that on the fourth day of incubation four small tubercles are formed round the ventral half of the first branchial groove; these, the colliculi branchiales externi, mark the beginning of the external ear; a little later a sack-like process, the canalis tubo-tympanicus, grows from the lateral aboral part of the branchial pocket, and forms the primitive drum-cavity. From the aboral end of the second arch an embryonic operculum projects over the third and fourth arches; the operculum and the main part of the second arch unite with their fellows of the opposite side to form a horseshoe hoop around the ventral part of the neck. Before this is well formed, the two colliculi branchiales externi of the second arch separate from the rest of the arch, and aid in forming the external ear. The third and fourth arches form a depression which is closed by the operculum blending with the thoracic wall. The tympanic membrane is formed by the membrane of His. From the dorsal part of the cleft an involution of ectoderm extends to the ganglion of the facial nerve and blends with it; this involution is one of the rudimentary branchial sense-organs, described by Van Wijhe, Froriep, and Beard.

Attachment of the Blastocyst to the Uterine Wall in the Bat.†—Prof. E. van Beneden has studied in *Vespertilio murinus* the attachment of the embryo to the mucous membrane of the uterus. He gives a brief description of the uterus and of the successive relations of the ovum, but devotes most attention to histological facts connected with the attachment of the blastocyst.

(1) The uterine epithelium degenerates completely. It disappears over the entire cavity of the uterus. It cannot therefore have any share in the formation of the maternal portion of the placenta.

(2) In *Vespertilio murinus*, the uterine glands have no relation to the placenta. They are wholly absent in that portion of the mucosa which corresponds to the placental ring of the blastocyst. In the animal under consideration there can be no question of the absorption by the placenta of a glandular secretion, spoken of as uterine milk in other mammals.

(3) At a very early stage in development, while the embryo is still two-layered throughout, before the formation of the primitive line or placental villosities, there obtains throughout the entire extent of the placental ring so intimate a union between the embryonic epiblast and the modified uterine mucosa, that it is difficult to distinguish the boundary between maternal and embryonic tissues.

Embryology of Anolis.‡—Mr. H. Orr has investigated the embryology of *Anolis zagræi*. He finds that the notochord extends forward in the head, along the line of the cranial flexure, and ends in a mass of fused hypoblast or epiblast, which forms the dorsal part of the oral fusion. From the hypoblastic portion of this mass of cells the head cavities arise; they retain for a considerable time their median connection with the anterior end of the notochord. The relation of the anterior end of the notochord, the head-cavities, and epiblast, precludes

* Johns-Hopkins Univ. Circulars, vii. (1888) p. 38.
† Bull. Acad. R. Sci. Belg., xv. (1888) pp. 17-26, 1 pl. (not appended).
‡ Johns-Hopkins Univ. Circulars, vii. (1888) p. 38.

in this case the supposition of a pre-oral intestine, and seems to argue against the theory that vertebrates once had a more primitive mouth placed anteriorly to that which they now possess. Previous to the development of any white matter in the brain six symmetrical swellings, separated by sharp lateral constrictions, appear in the hind-brain; these are homologous with the medullary folds found by Kuppfer in osseous fishes; in the lizard they give rise to the roots of the fifth, sixth, common root of seventh and eighth, and roots of the ninth and tenth nerves; it is proposed to call these swellings neuromeres. About the time of disappearance of the neuromeres, nerve-fibres begin to appear as lateral bands of longitudinal fibres passing along the lateral external surface of the spinal cord and brain, and uniting in a single band on the morphologically anterior surface of the brain immediately ventral to the optic stalks. The fibres of the optic nerve appear on the internal surface of the eye-cup, and on the anterior surface of the hollow of the stalk; they differ from the fibres of all other nerve-roots in not being developed as polar outgrowths of the cells.

Shortly after the first appearance of lateral bands of fibres a second system begins to develope as polar outgrowths of the cells lying just internal to the lateral band; they extend ventrally, and form a continuous ventral commissure, which ends at the point where the floor of the midbrain merges into the infundibulum. About the same time the commissures of the anterior part of the brain begin to develope; they are all morphologically dorsal, and are nearly similar in their development. The author has obtained essentially the same result with urodelous and anurous Batrachians.

Development of Petromyzon.*—Dr. W. B. Scott, in the present memoir, deals only with the development of the nervous system and sensory organs of *Petromyzon*. He finds that the upper lip rotates through an arc of 180°, and this has a great effect on the development of the anterior organs of the head. In the freshly hatched larva the brain, and especially the fore- and mid-parts, are exceedingly small, in correlation, no doubt, with the undeveloped condition of the sense-organs during the greater part of larval life. The cranial flexure is always slight, and is partly corrected by a rotation in the opposite sense. The hemispheres arise as an unpaired solid mass, and the olfactory lobes are formed from them. The infundibulum is a diverticulum of the thalamencephalon, which is at first single, but afterwards divides into lobus and saccus; the epiphysis arises as in other vertebrates, and soon exhibits its character as an optic vesicle, but has no lens; the primary gives rise to a secondary vesicle which enters into close relations with the left ganglion habenulæ; the changes in characters and relations which it undergoes suggest that it has acquired some secondary character of importance, but what that is cannot be guessed. The right ganglion habenulæ is from the first much larger than the left; the former comes to project above the roof of the brain, and the latter divides into two portions which are connected by a fibrous stalk.

The pituitary body is derived from the epiblast of the surface of the head in close connection with the olfactory involution; Dr. Scott believes that this connection is secondary; the morphology of this structure

* Journ. of Morphology, i. (1887) pp. 253–310 (4 pls.).

is discussed at some length, and it is believed to be the rudiment of a canal which once opened on the surface of the head. In correlation with the retarded development of the eyes the optic lobes do not appear till late in larval life. The cerebellum is formed from the posterior wall of the dorsal fold between the mid- and hind-brains, and long remains very minute. The spinal cord in the later embryonic and early larval stages is like that of the higher vertebrates; the characteristic flattening is effected during larval life.

The peripheral nerves are developed much as in Selachians; the olfactory nerves are originally paired, and the optic are at first remarkable for their great length; the trigeminal has two, and the facial has one ganglion formed from the skin.

The epidermal sense-organs of the head and lateral line are not developed in connection with the ganglia of the cerebral nerves, or with the lateral nerve, but at a later stage; this, however, is looked upon as a secondary process. The olfactory organ is at first ventral in position, and is always single and median; the rotation of the upper lip brings the opening to the dorsal side of the head, and it was probably this condition which produced the coalescence of the primitively paired nasal pits. A glandular organ, resembling that of Jacobson, but having no communication with the mouth, is formed from the postero-inferior portion of the nasal involution. The eye is formed as in other vertebrates, but is remarkable for the very small part of the primary optic vesicle which gives rise to the retina; the retinal elements appear only just before metamorphosis, and no cornea is present in the larva; the lens is probably of mesoblastic origin. The ear, in its early stages, is like that of other vertebrates, and the first divergencies appear in the young larva. There is no trace of the horizontal semicircular canal; the vestibule is divided imperfectly into chambers, and a median appendix is formed. This organ is relatively better developed in the larva than either nose or eyes, and does not undergo such marked changes at metamorphosis. Dr. Scott considers that the sense-organs of *Petromyzon* do not show degeneration, but rather retardation of development. There are certain minor peculiarities which appear to have been acquired within the Cyclostomatous phylum, but they cannot be regarded as degenerate; such are the union of the nasal pits, and the development of the naso-palatal canal; the peculiar structure of the retina; the absence of the horizontal semicircular canal, the division of the vestibule into chambers, and the presence of the auditory appendix.

Development of Torpedo ocellata.*—Prof. A. Swaen, in the first part of his memoir, deals with the formation of the gastrula, of the mesoblast, and of the notochord in *Torpedo ocellata*. He finds that the mesoblast arises throughout the blastoderm from a mixture of epi- and hypoblastic cells. In the anterior part it arises from the special cellular zone which connects the epiblast and hypoblast; in the posterior part it arises indirectly, in the sense that the zone of cells commences by forming a special layer (the secondary hypoblast), from which alone the mesoblast takes its origin. The notochord is found to be developed from the endoblast of the digestive tube, on the roof of which a notochordal groove is first formed. The epithelial cells of the groove are, in consequence of their orientation around the notochordal axis, partly isolated from the

* Arch. de Biol., vii. (1887) pp. 537–85 (3 pls.).

rest of the wall. The epithelial cells in the neighbourhood pass from without inwards, and lie below the cord, where they gradually become isolated. The dorsal wall of the embryo is developed as in *Amphioxus*. The epithelium which forms the upper wall of the cavity of the gastrula gives rise to the two halves of the mesoblast and to the notochord, just as in *Amphioxus*.

β. Histology.*

Nervous System of Amphioxus.†—Dr. E. Rohde has made an investigation into the structure of the nervous system of *Amphioxus*, and finds a close resemblance between it and that of the same system in the polychætous *Sthenelais*. In both there are certain nerve-fibres which are remarkable for their great size, constant position, and enormous lengths. These colossal nerve-fibres are the processes of colossal ganglion-cells, which are placed at definite distances from one another, partly at the anterior (though rare in the brain), and partly at the hinder end of the central nervous system. These fibres, which run from before backwards, break up into an unpaired median fibre (which is always the largest), and paired lateral fibres, and they are connected by fine lateral branches with the other nerve elements. In both forms the supporting tissue is of ectodermal origin.

Changes of Position of Nucleus.‡—Herr O. Schultze describes some of the changes of position observed in the nucleus. (*a*) *Passive displacements.*—The nucleus may be pressed to the surface by accumulations of different substances, e.g. fat and mucus. (*b*) *Active displacements.*—These are associated with the maturation and fertilization of the ovum. Auerbach has described the rotation of the nucleus in the fertilization of *Rhabdonema nigrovenosa*. This is explained by O. Hertwig as due to the mutual influence of protoplasm and nucleus. Various observers have noticed the change of position associated with the extrusion of polar globules. Herr Schultze observed this in the ova of Amphibians, and especially of *Siredon*. He explains it in terms of Hertwig's law, that the stretching of the nucleus must take place in the direction of the greatest aggregation of protoplasm within the cell. In mammals a similar turning of the directive spindle seems to occur, as the author's observations on the ova of guinea-pigs, taken along with what Flemming has described, certainly suggest.

Chemistry of the Nucleus.§—Prof. A. Kossel points out in connection with adenin that the most recent researches on the importance of the nucleus to the life of the cell (especially the knowledge that when unicellular organisms are artificially cut into pieces, only those parts exhibit a complete regeneration which contain a portion of the nucleus), and the importance of the nucleus in impregnation have given an increased importance to the chemistry of the nucleus.

Among the chemical substances which compose the nucleus, adenin, which has recently been discovered by the author, appears to possess a special importance, since, on account of its composition, $C_5H_5N_5$, it belongs to the cyanic group of bodies. This substance was obtained

* This section is limited to papers relating to Cells and Fibres.

† Zool. Anzeig., xi. (1888) pp. 190–6.

‡ SB. Phys.-Med. Gesell. Würzburg, 1887, pp. 4–5.

§ Nature, xxxvii. (1887) p. 168, from Proceedings of Berlin Physiological Society, 1887, Nov. 18.

from tea-leaves in large quantities, and from it a series of compounds, which were exhibited as extremely fine preparations; namely, the salts with hydrochloric, sulphuric, and nitric acids, as also some compounds with platinum. Adenin was found to be extremely resistant to feebly oxidizing agents, but, on the other hand, to be easily acted upon by reducing agents. The substances which are produced by these means were not very well characterized from a chemical point of view. The author, however, thinks that, owing to the ease with which it can be reduced, adenin plays an extremely important part in the physiological action of the nucleus. When adenin is reduced in presence of oxygen a brownish-black substance is obtained, which appears to be identical with the azocuminic acid which is produced when hydrocyanic acid is exposed to the air for a long time. In conclusion, adenin makes its appearance in large quantities under certain pathological conditions, and the author has succeeded in detecting it in the urine of persons suffering from leuchæmia.

Pathological Structure of the Cell-nucleus.*—Prof. W. Pfitzner draws attention to the fact that the lower we descend in the animal kingdom, the nuclei are found to be so much the poorer in chromatin. The same holds good for the vegetable kingdom. The development of chromatin is in proportion to the stage of development of the cell. In a young animal the nuclei are poorer in chromatin than in an older one. A small amount of chromatin is an indication of the embryonic character of the cell. Unfertilized ova of animals and plants show this poverty in a very striking way. On fertilization an increase of the nuclear chromatin of the ovum occurs through the head of the spermatozoon which contains a considerable quantity of chromatin, and whereby an increase in the vital energy of the cell is produced. In the nuclear chromatin are seen changes due to age, and these the author describes in the cornified epithelium of the epidermis, and in the epithelium of the cornea and of the oral cavity. The horny condition is associated with degeneration of the nucleus, the chromatin substance becoming less refractive and colourable, and thus disappears, or the form of the chromatic nuclear constituents becomes so altered that finally it assumes the form of so many separate lumps. Both processes may take place cotemporaneously. Secreting cells also show nuclear degeneration. If the cell-body be filled out with the secretion, the nucleus seems crumpled up, and the chromatin packed closer together; after evacuation it resumes its normal appearance. In most cases effective work in a secreting cell is associated with considerable wear and tear. In sebaceous glands the nuclei of cells which line the walls of an acinus show normal structure, and frequently mitosis. The cells filling up the gland lumen, however, show, and more clearly the nearer they are to the orifice, appearances which recall the corneous cells of the epidermis; the nucleus becomes small, round, homogeneous, and loses in power of refracting and of receiving colours, and finally is lost in the cloudy cell-contents. The nucleus of perfect goblet-cells shows similar appearances.

In the salamander larva karyokinesis of the red blood-cells takes place in the whole of the circulatory system; in the adult salamander, only in the spleen. In the blood of the larva there are found also cells which show changes due to age in addition to the fully formed cells. After the

* Virchow's Arch. f. Path. u. Hist. Anat., ciii. (1886) pp. 275–300 (1 pl.).

nucleus has divided karyokinetically, it passes through the star and skein forms into the network and nucleoli form again. As the volume of the nucleus diminishes, the chromatin network becomes smaller and plumper, and the nucleoli present in the majority become quite large, while owing to the condensation of the chromatin network, they become more and more imperceptible. In the blood of adult larvæ no actual nuclear figures appear, but nuclei and the same transition forms up to the homogeneous stage, as in the larvæ. But here the atrophy increases rapidly, the chromatin network becomes coarser, the nucleus assumes a mulberry shape, becomes flat, and loses its power of refraction and of taking up dyes more and more, until it has completely vanished. Non-nucleated blood-cells are found in some animals which have fasted for half a year and more. Nuclei of leucocytes in their sites of proliferation always present a normal structure, but outside this, various changes, as rarefaction of the chromatin network, or a massing together of it. If the leucocytes outside their sites of formation seem to divide directly, this is to be regarded as a pathological change, and indeed everywhere where a nucleus divides without mitosis.

Besides senile degeneration the nucleus may become altered from purely pathological conditions. When the author incised the snouts of dogs, rabbits, or guinea-pigs, or scratched the cornea with a needle, he found that the cells between the wound and the regeneration area showed changes which resembled those of senile atrophy. Sometimes the morphological, sometimes the chemical decomposition of the chromatin network predominated. In the nests of epithelioma the nuclei diminish in volume and then lose their refractive power and capacity for staining. The difference between the regeneration of epithelium under normal circumstances and in inflammatory and neoplastic conditions consists in the greater number of figures found in the latter. Secondly (and principally) the nuclei are strikingly poorer in chromatin than in the healthy parts of the same organ, and the figures correspondingly smaller. Accordingly, both the cells of malignant tumours and epithelia of inflamed parts present similar characters to those of embryonic cells. That parasitic disease can influence cell-structure, follows from the author's observation that mould fungi affect in a characteristic and constant manner the form of the chromatin structure of the cell-nucleus.

Segmentation in Axolotl.*—Herr O. Schultze confirms Bellonci's results as to the karyokinesis of the first segmentation cells of the Axolotl.

The framework of the resting nucleus does not pass by direct modification into the nuclear coil, which lies at the periphery, while the framework is still recognizable within. It seems as if the coil originated from an entirely fresh molecular grouping. In the wall of the nucleus small granules (Pfitzner's granules) appear, and these seem to group themselves to form the coil.

The importance of the attractive spheres or centres is then emphasized. They consist of filar and interfilar substance. The former is associated with radial arrangement in the body of the cell, and the "amphiaster" is most distinct at the commencement of the so-called star form of the daughter nuclei. Former observations on the formation of the daughter nuclei are confirmed.

* SB. Phys.-Med. Gesell. Würzburg, 1887, pp. 2–4.

Glandular Cells of Stomach.*—M. A. Pilliet has made a comparative histological study of the morphology and evolution of the glandular cells of the stomach.

The first type of principal cell may be described as prismatic, and is found in the first portion of the tubes. The nucleus is at the base of the cell, the network is variable, the general appearance is opaque, but also variable. The second or cubical type is represented by two forms, (*a*) by cubical cells in the second portion of the glands, with well-defined network, more or less developed, the appearance more or less opaque, the nucleus in the centre of the cell, and (*b*) by cubical or polyhedral cells in the same situation, with much restricted network, with a clear appearance, and with a mucous development in the interjacent plasma ("infiltrat"). This last is known as Heidenhain's stage.

The limiting cells are really identical with the principal. Two phases may be distinguished, (1) Nussbaum's stage, where the cells are round, refractive, and granular, with the nucleus proliferating, with possible mucous development; (2) the state of coagulation where the round cells are homogeneous, refractive, and with atrophied nucleus.

The evolution of a glandular cell of the stomach is comparable to that of any other epithelial cell, either ecto- or endodermic. The principal prismatic cell, like the other cells of the intestine, is transformed into a cubical cell more or less globular. At a further stage the cell becomes laden with large granules, begins to undergo coagulation, and passes into the homogeneous phase. The limiting cell ("cellule bordante") which results, is characterized by the development of the albuminoid network and by the accomplishment of coagulation and infiltration. The latter is due especially to the ternary compounds of metabolism, and developes in proportion to the vital activity of the albuminoid network. The elements become tumid and globular. Coagulation becomes complete, the cell falls into the stomach cavity, and undergoes disintegration. The same process occurs throughout. The evolution must be described as in part mucous and in part coagulatory. Either type may occur on to an advanced stage. Research must establish the chemical differences in the inter-reticular cytoplasm or enchylema, and on this fundamental point some classic investigations have already been made.

Division and Metamorphosis of Wandering Cells.†—Dr. J. Arnold has made a detailed study of the processes of division in wandering cells, and of their progressive and retrogressive metamorphosis. On this subject satisfactory information has long been wanted. Following Ranvier, Arnold utilized plates of elder-pith on which to observe the cellular changes. The experiments and observations on living cells were controlled by the study of preserved phases.

A. (1) Both on living and preserved specimens it was seen that the wandering cells could divide by a process of fragmentation. (2) This is associated with changes in the form of the nucleus, conditioned by active movements, and probably also with changes in the form of the cells themselves. (3) Before, during, and after division, the content of chromatic filaments is very frequently increased. The diffuse staining, especially of the polymorphic nuclei, represents both a state of contraction in the

* Journ. Anat. et Physiol. (Robin), xxiii. (1887) pp. 463-97 (1 pl.).
† Arch. f. Mikr. Anat., xxx. (1887) pp. 205-310 (5 pls.).

nuclei and also an increase in the diffuse stainable substance. (4) From a diffuse staining of the nuclei degeneration cannot be directly inferred, and especially not in the sense that the form in question owes its origin to a degeneration. (5) The succession of the various phases of division is in fragmentation very frequently by no means regular. Nuclei and cells may persist for long in one stage. The occurrence of polynuclear and of united cells is thus intelligible.

B. (1) From larger and smaller wandering cells polynuclear elements may arise by fragmentation, without any division of the cellular body at first occurring. (2) In such processes very complex nuclear figures are at times formed, and the nucleus is sometimes simply constricted. (3) An increase in the chromatic substance was frequently, but not constantly observed. (4) Observation of living objects shows that from giant-cells nucleated elements may be given off, sometimes in the form of processes, sometimes simply peripherally.

C. (1) That wandering cells may divide according to the ordinary type of mitosis is very probable, but not certain. Division by fragmentation is, on the other hand, very frequent. (2) The discovery of mitosis in the elements of the blood, lymph, and lymphatic organs cannot be held as a proof that the lymphocytes usually divide in this fashion, far less that they do so exclusively. Deductions from these elements to wandering cells, and *vice versâ*, are not directly admissible, since the two kinds of cells are not homologous, and may in different conditions divide differently. (3) Polynuclear cells arise on the plates usually by fragmentation, much less frequently by mitosis. The two processes must not, however, be too rigidly separated, nor must the difference be minimized, for in fragmentation the typical disposition of chromatic filaments is different, the relation of the nuclear membrane is different, the contour is usually sharp, &c.

D. The nuclear degeneration is next discussed. This may take three forms—(1) simple disappearance of nucleus, without disorder of chromatic substance; (2) nuclear degeneration, in which disorder of the chromatin precedes disappearance; (3) degeneration of the figures of division or abortive division.

E. Progressive changes are next described. Whether the wandering cells finding their way into the tissue may break up, or remain and pass through progressive changes, is undecided. It is yet more doubtful whether they play a part in the development of the granular and connective tissue, for instance of the vessels. That progressive metamorphosis is impossible must not be concluded, since many of the experimental conditions were not favourable to such changes. The cells which were allowed to grow on the above-mentioned plates (on the mesentery), united together in continuous layers, and became flat, with dull protoplasm and vesicular nucleus. So in plates placed in the lymph-sacs, it seemed almost demonstrable that the cells changed within the recesses of the plate. The cells in the meshes became epithelioid and giant cells, before the development of tissue and vessels proceeding from the walls of the lymph-sacs had penetrated the most external layer of the lymph thrombus. The epithelioid and giant cells may persist for long as such before the above-mentioned development reaches the surface of the plates. As to the share of the epithelioid and giant cells in the formation of connective tissue, no conclusion was arrived at. In the thrombus at a later stage the epithelioid cells could not be distinguished from the

elements which had grown in; and further, in cells within the meshes no development of connective substance was to be observed, even after a long time.

The research concludes with a chapter on the epithelioid and giant cells, and with further discussion of the relation of wandering cells to the problems of histogenesis.

Histology of Nerve-fibres.*—Herr Joseph has investigated the accuracy of Kupffer's conclusion that the axis cylinder of medullary nerve-fibres was fibrillar in structure. As the object of investigation he chose the electric nerves of *Torpedo marmorata*.

His results led him to conclude (*a*) that in the axial space there is a fine network, in the meshes of which the nerve-fibrils lie. In a normal nerve-fibre the axial space must include the greatest contingent of fibres, and exceed by five or more times the diameter of the medullary sheath. In this axial space a network is for the first time distinctly determined. The author criticizes as without sufficient basis the recent conclusions of Nausen. (*b*) In the medullary sheath, he notes, besides the fat-spherules (stained grey with osmic acid), a strongly refractive, generally darkly stained framework. He believes that there is a second constituent in the medullary sheath. This Ewald and Kühne proposed to term "neurokeratin," but as Herr Joseph failed completely to verify their experiments (in which this framework persisted in digestion), he thinks that the use of the term is unjustifiable.

Development of Red Blood-corpuscles.†—M. L. Cuénot submits the results of his observations on the development of the coloured corpuscles of the blood. (*a*) The spleen of any of the lower vertebrates includes two sets of nuclei, surrounded by a little protoplasm. The smaller are the nuclei of the red blood-corpuscles; the larger become amœboid white blood-corpuscles. (*b*) The rest of the development must be studied in the blood. He is convinced that the nucleus of the leucocyte never developes into a red blood-corpuscle. (*c*) The smaller nuclei above mentioned acquire a more regularly contoured surrounding of protoplasm. The nucleus gives off from its surface little refractive granules, and becomes in consequence reduced in size. At adult size the secretion of hæmoglobin begins in the cell. The nucleus thus appears to have an important rôle in the formation of hæmoglobin. The process was observed in fishes, amphibia, reptiles, and birds. (*d*) In mammals the development above indicated takes place wholly within the spleen.

B. INVERTEBRATA.

Cœlom and Vascular System of Mollusca and Arthropoda.‡—Prof. E. Ray Lankester points out that the system of blood-containing spores which pervades the body of Molluscs and Arthropods is not equivalent to the cœlom or perivisceral space of Chætopoda and Vertebrata, but is a distended and irregularly swollen vascular system; the cavities may be called "hæmocœl" in contradistinction to cœlom. In the Mollusca the chief representative of the true cœlom is the pericardial space; this does not communicate with the vascular system and does not contain

* Arch. f. Anat. u. Physiol. (Anat. Abtheil.), 1888, pp. 184–7 (Physiol. Gesell. Berlin).

† Comptes Rendus, cvi. (1888) pp. 673–5. ‡ Nature, xxxvii. (1888) p. 498.

blood. The perigonadial spaces (so-called generative glands) are also cœlomic in character, and in Cephalopods and the archaic *Neomenia* they are continuous with the pericardium. In both Molluscs and Arthropods the ancestral blood-vessels have swollen and enlarged, so as to form large irregular spaces which have blocked up and so obliterated the previously existing cœlom. In the Arthropoda the cœlom is represented by the tubular generative gland, and as a system of small spaces (lymph-spaces) in the connective tissue of *Astacus* and *Limulus*, and as the internal terminal vesicle of the green glands and other nephridia present in various Arthropoda. The heart and pericardium of the Arthropoda are absolutely peculiar to the group, and characteristic of all its members.

Prof. Lankester considers that each pair of valvular apertures in the heart of an Arthropod represents a pair of distinct tubular veins, which in the ancestral form brought blood to the heart from the gills. These veins have dilated, and their adjacent walls have been absorbed, so that we now have, instead of a series of veins, a great continuous blood-series on each side of the heart or dorsal vessel. Capillaries of the finest dimensions have been found in certain parts of *Astacus* and *Limulus;* between them and unconnected with them, in the connective tissue, there is a system of spaces containing a coagulable fluid; into this system the tubular nephridium, which becomes the coxal gland of *Limulus*, opens, so that these are remnants of the cœlom, elsewhere blocked up and obliterated by the swollen veins which form the hæmocœl. The tubular generative glands of Arthropods are to be explained as perigonadial cœlom communicating with the exterior through modified nephridia.

Mollusca.

a. Cephalopoda.

Homology of Germinal Layers of Cephalopods.* — Mr. S. Watase has a preliminary communication on the formation of the germinal layers in *Loligo Pealii* and other Cephalopods. A noticeable feature in the distribution of the food-yolk and germinal protoplasm is that the line of demarcation between them is perfectly distinct from the beginning of the embryonic history, so that segmentation goes on regularly without any disturbing effect on the food-yolk.

In the stage which is regarded as the gastrula stage, the germinal disc consists of three zones—the central, which is a circular area of single cells; the intermediate, two-cell-thick, zone; and the marginal single-cell zone; some of the cells of the intermediate zone are spindle-shaped, and so show the characteristics of the future yolk-membrane cells. This germinal disc may be regarded as an inverted gastrula with its concave side turned towards the yolk-mass; the line of junction between the marginal zone and the food-yolk corresponds to the lip of the blastopore, and the shallow cavity to the archenteron. Looked at in this way, the first origin of yolk-membrane cells near the inner side of the marginal zone fully justifies its comparison with the lining of the gastrula cavity or to the hypoblast. The delamination of the intermediate zone before the completion of the lining of the gastrula cavity must be looked upon as precocious development due to the influence of food-yolk.

It is clear, then, that the author recognizes in the early stages of

* Johns-Hopkins Univ. Circ., vii. (1888) pp. 33–4.

Cephalopods the existence of three germinal layers, the outer columnar epiblast, the intermediate polygonal mesoblast cells, and the inner spindle-shaped hypoblast cells. The evidence as to the yolk-membrane being the hypoblast is further discussed, and some objections to this view are noted. The fact that it does not take any part in the formation of the digestive tract, which consists only of fore-gut and hind-gut, may be explained by the quantity of food-yolk to be absorbed being so large that other structures are completed before it is all absorbed.

Shell-growth in Cephalopoda.*—Mr. F. A. Bather returns to this subject.† His conclusions are that the whole of the true shell, and the whole of the sheath are first formed in chitinous membranes, secreted by the visceral hump and mantle respectively; these become calcified by the deposition in their interstices of arragonite and calcite respectively; there is no intussusception, except of lime, and that is probably a physical process. Secretion of chitin continues after growth ceases, and may be accelerated in phylogeny. The rate at which lime is deposited is independent of the animal, and hence extent of calcification varies inversely as rapidity of chitin secretion.

Systematic Arrangement of Cranchia.‡—Dr. J. Brock, referring to Mr. Hoyle's report on the 'Challenger' Cephalopoda, in which *Cranchia Reinhardtii* of Brock is regarded as not identical with the type specimen of Steenstrup, which is preserved in the Copenhagen Museum, enters into some details as to his specimen; the differences do not appear to him to justify the formation of a new species.

γ. Gastropoda.

Spermatogenesis in Aplysia.§—M. E. Robert has investigated the development of spermatozoa in *Aplysia depilans* and *A. fasciata*, where he finds two different processes. In the first, which appears to be the more normal and frequent, the nuclei of the spermatoblasts divide into a certain number of parts; these elongate and take on the form of spiral filaments, while the nucleus continues to grow; the filaments, which are the heads of the spermatozoa, separate from one another. As the nucleus grows it seems to absorb the surrounding protoplasm, which becomes reduced to a delicate zone. At maturity the protoplasm of the spermatoblast is all absorbed by the nucleus. The nuclein is divided into a number of spiral filaments, each of which is the head of a spermatozoon. The nucleus bursts, and the heads of the spermatozoa escape in the form of large Vibrios. The author believes that the tails of these elements are formed by the elongation of a portion of the spermatoblastic protoplasm which is carried away by the cephalic filament of chromatin.

In the second mode of development the spermatoblastic cell gives rise to only one spermatozoon. The nucleus, instead of dividing into distinct masses, elongates at one extremity, and takes on the form of a strongly curved rod; its other end elongates, and it becomes of an elongated fusiform shape. Finally the middle becomes more delicate, and elongates in its turn. This elongation is not, however, straight, but

* Ann. and Mag. Nat. Hist., i. (1888) pp. 298–310.
† See this Journal, *ante*, p. 200.
‡ Nachr. K. Gesell. Wiss. Göttingen, 1887, pp. 320–2.
§ Comptes Rendus, cvi. (1888) pp. 422–5.

spiral in direction. Here the tail of the spermatozoon is more distinctly than in the first case formed at the expense of the protoplasm of the spermatoblast. The amœboid pseudopodia, which have been described, are nothing more than the first stage in the elongation of this protoplasm.

The differences in the modes of development depend on the more precocious fragmentation of the nucleus in the first case, and there is no morphological value in the difference between these two kinds of spermatozoa.

Reproductive Organs and Oogenesis of Helix.*—M. P. Garnault has studied by means of sections the structure of a portion of the reproductive organs of *Helix aspersa*, and also the mode of oogenesis and the first stages in fertilization.

(1) In regard to the organs, the portion known as the "diverticulum" or "talon" at the corner of the albumen gland has been studied. The efferent canal forms, near its posterior extremity, a sort of sac, bordering on the concavity of the albumen gland. This sac is the swollen end of the efferent canal. A little below the point where the swollen portion of the efferent canal is pressed into the albumen gland, it gives origin laterally to a tube, lined by ciliated non-granular epithelium. This tube branches into 3–8 ramifications, ending in culs-de-sac, and lodged between the ascending and the descending or swollen portion of the efferent canal. In the adult these tubes are filled with living spermatozoa.

(2) In regard to the oogenesis, (*a*) the follicle is formed from the cells of the germinal epithelium, becomes delicate in adolescent ova, and is absorbed on dehiscence. (*b*) The nucleus of the adult ovum has a distinct membrane; it contains a large deeply stained sphere, and a still more deeply stained corpuscle within the latter. There is a well-developed karyoplasmatic network, with intensely stained corpuscles at the nodes. The large nucleolus and accessory nucleoli are formed by the concentration of the chromatic material of the network.

(3) When the *Helix* is beginning to deposit ova, the swollen portion of the efferent canal is seen to be full of sperms and ova. Admirable preparations were obtained by 3 per cent. nitric acid and by Delafield's hæmatoxylin. The vitelline expansions discovered by M. Perez were well seen over the whole ovum or at the poles. Their formation is probably due to the irritability of the vitellus evoked by the action of the spermatozoa.

(4) The author then describes the formation of polar globules, and is convinced that the process has the significance of cellular division.

(5) The sperms penetrate the ovum usually by the vitelline expansions, which seem to be "cones of attraction." They soon lose their tail and the head increases. Three male pronuclei were sometimes seen in one ovum. The pronuclei increase by the apposition of stainable granules from the vitellus. They soon acquire stellate form, with a central mass and three, increasing to six, lateral masses. The volume increases with the complexity. Never more than one enlarged male pronucleus was seen in the ovum. No male aster was to be seen. The

* Comptes Rendus, cvi. (1888) pp. 675–8.

pronuclei occur sometimes at the germinative pole near the directive amphiaster, but usually at the other end of the ovum. They move very slowly in the vitellus, which at the most advanced stage observed did not possess a vitelline membrane. M. Garnault notes in conclusion that M. R. Blanchard has also suggested that the male pronucleus developed at the expense of the substance of the germinal vesicle, but has given no evidence, and further that the observations above summarized in regard to the male pronucleus hardly agree with what Platner has described in *Arion*.

Mantle of Gastropods and Dependent Organs.*—M. F. Bernard continues his investigation of the structures associated with the mantle of Gastropods.

(1) *Monotocardii ; false bipectinate gill.* The author has previously described the structure of this organ, but adds some notes on the nervous terminations. In the epithelium, outside the basilar membrane, the terminal ramifications of the nerves end in a network of multipolar cells. The terminal cells end in little rods, often reduced to minute heads plunged in the pigment of the non-ciliated epithelial cells which surround them. The neuro-epithelial cells may be distinguished by the absence of cilia.

False gills with a single ganglion have been observed by Lacaze-Duthiers, and by the author in *Vermetus*, *Paludina*, *Littorina*, *Bithynia*, &c. His observations on *Cyclostoma* agree with those of Garnault. The peculiar structure of the false gill of *Paludina* is described.

(2) *Diotocardii.* In reference to the observations of Spengel, Bouvier, and Wegmann, the author maintains that there is in the branchial support of Diotocardii no trace of rudimentary gills; the branchial ganglion and nerve are exactly as in *Littorina*.

(3) The structure of the false gill is not essentially different from that of other portions of the mantle, but the neuro-epithelial terminations are more numerous, more constant, and better grouped. Their sensitive function does not seem doubtful; but to say that they are olfactory is premature.

(4) In Prosobranchs, in all the organs associated with the mantle and with the foot, there is neither cartilaginous nor capillary structure. The modifications of connective, muscular, and epithelial tissue differ only in the proportions of their elements. Thus neuro-epithelial, secretory, pigmented, and indifferent epithelium occur throughout, but in certain regions (tentacles, false gill) the former predominates, and the regions become sensitive. In the mucus-glands, purple-glands, and certain parts of the branchial lamellæ glandular tissue predominates. All parts seem equally adapted to respiratory function.

Kidney of Monotocardate Prosobranch Gastropods.†—M. R. Perrier has examined particularly the renal organ of *Littorina littorea*. He finds that the secreting apparatus is composed of a series of anastomosing lamellæ, one edge of which is attached to the wall of the renal sac, while the other hangs freely in the cavity. Along the short edge there is a vessel, the walls of which are distinctly bounded, and it extends throughout the whole of the lamella. The renal vessels all arise from a common trunk which has its origin in the sinus which surrounds the intestine ; they contain venous blood, divide frequently, and convey the

* Comptes Rendus, cvi. (1888) pp. 681–3. † Ibid., pp. 766–8.

blood to a vast system of lacunæ which is contained in the interior of the lamellæ. These lacunæ are partly occupied by connective cells and fibres, and by muscular fibres, and they communicate with superficial lacunæ in the wall of the body.

The glandular epithelium lies on a delicate basal membrane, the cells of which are arranged in a single layer; some of these cells are large, are quite devoid of cilia, and are glandular in function, while others are ciliated and gradually diminish to a delicate peduncle which is inserted in the basal membrane. The mechanism of secretion is very remarkable; the author has never seen the cells detach themselves and fall into the cavity in the way which has always been described, but the excreted materials collect near the apex of the glandular cell in a vacuole which gradually increases in size, and contains solid concretions. This vacuole has sometimes been regarded as a second cell formed endogenously. When the vacuole is sufficiently large the cell projects into the cavity, and allows the vacuole to fall out.

The glandular tissue of the kidney does not reach the pericardium; all along the latter there is a special organ. It is a large lacuna in the form of a canal, which freely communicates with the auricle; it is composed of a tissue formed of stellate connective cells, which make a wide-meshed plexus. Wide ramified canals, lined by ciliated cells, pass into the lacuna, and open by numerous orifices into the renal cavity.

The Orthoneura.—The memoir of Dr. H. von Ihering* on the Orthoneura is critically noticed in Prof. Lacaze-Duthiers' 'Journal.'† The author attempts to support the division of the Prosobranchiata into Orthoneura and Chiastoneura against the criticisms of B. Haller, Spengel, Bütschli, and others by an account of the arrangements which obtain in the nervous system of *Ampullaria*. He comes to the conclusion that Spengel and Haller have regarded as a visceral commissure an anastomosis of the visceral nervous system, and he contends, therefore, that the Mollusca which they studied are really orthoneurous and not chiastoneurous. The anonymous critic points out that M. Bouvier has shown that in *Ampullaria* the right commissural ganglion connected with the corresponding pedal ganglion is not simple, but is equivalent to the right commissural ganglion and the subintestinal; that there is a twisted visceral commissure formed by its visceral commissure, a part of its visceral loop (the plexus), and by a dorsal nerve which had escaped Dr. Ihering's attention; if this be so, Ihering's argument fails, inasmuch as the type which he selects is chiastoneurous itself. Bouvier has also shown that the nerve which Ihering describes as arising from the right commissural ganglion and going to innervate the gill is not a branchial nerve, but a pallial one, and that the right gill of Ihering is always a left gill, innervated by the supra-intestinal ganglion and the part of the visceral commissure which unites the supra-intestinal ganglion to the abdominal ganglion.

The critic thinks that the new work of Dr. Ihering fails to establish the existence of orthoneurous Prosobranchs, all of which are chiastoneurous except the Neritinæ and Helicinæ, which present an apparent orthoneury.

* Zeitschr. f. Wiss. Zool., xliv. (1887) pp. 499–531 (1 pl.).
† Arch. Zool. Expér. et Gén., v. (1887) pp. xvii.–xx.

The following is Ihering's classification of Mollusca:—

MOLLUSCA.

Class I. Amphineura.
„ II. Acephala.
„ III. Cephalopoda.
„ IV. Solenoconchæ.
„ V. Cochlides.
Order 1. Chiastoneura.
„ 2. Orthoneura.
„ 3. Heteropoda.
„ VI. Protocochlides (Rhodopidæ).
„ VII. Pteropoda.
„ VIII. Ichnopoda.
Order 1. Nudibranchiata.
„ 2. Pleurobranchia.
„ 3. Steganobranchia.
„ 4. Branchiopneusta.
„ 5. Nephroneusta.

Classification of Gastropods, based on the Arrangement of the Nervous System.*—Prof. H. de Lacaze-Duthiers has summed up the results of his well-known work on various types of Gastropods. In it the "law of connections" has been his surest guide, and has been most rigorously applied. He has more than once urged that there are four nerve-centres around which all secondary ganglia can be grouped; three of them are symmetrical—the cerebral, the pedal, and the stomato-gastric. The fourth is asymmetrical, and is always composed of more than two ganglia; there are often, indeed, as many as five. This asymmetrical centre may be looked upon as the characteristic organ of the group, and Prof. Lacaze-Duthiers considers that its variations afford the best basis for classification.

When the asymmetric commissure is very short, all the ganglia touch and form an arc which is connected with the brain by a connective equal in length to the cerebro-pedal connective; in this case the centre is a little below the pedal ganglion, and in front of the digestive tube; to this type the term gastroneural may be applied; it is found in terrestrial and aquatic Pulmonata, *Gadinia*, *Onchidium*, and *Ancylus*.

In the second type the asymmetric centre is divided into two, and occupies a dorsal position; the connectives uniting the centre are so short that they seem to disappear, and all the ganglia appear to have passed to the dorsal side of the digestive tube; this notoneural type is well marked in *Tethys*, and is found also in Tritonidæ, Doridida, Ombrellidæ, and Æolidiæ.

In the pleuroneural type, which is seen in *Aplysia*, *Bulla*, and *Philine*, the asymmetrical ganglion lies at a distance from the rest, and on the right side; in the strepsineural condition there is further torsion of the connectives, and this torsion may come from the dorsal (aponotoneural) or from the pedal (epipodoneural) surface; of the former the Pectinibranchiata, and of the latter the Fissurellidæ and Haliotidæ are types. The latest classification of the Mollusca is then:—

I. Astrepsineura.—1. Notoneura; 2. Gastroneura; 3. Pleuroneura.
II. Strepsineura.—4. Aponotoneura; 5. Epipodoneura.

* Comptes Rendus, cvi. (1888) pp. 716–24.

δ. Lamellibranchiata.

Mucous Cells in Mussels.* — Dr. B. Rawitz has found in the mantle of Mussels goblet-cells, of which some are small, with a large central nucleus and granular protoplasm; others are large, with a small central nucleus, the rest of the cell-contents being uniform in appearance; and others again are large, with a small nucleus situated at the base of the cell, the protoplasm having oily granules scattered throughout itself. This last kind of cell allows the oily granules and mucous contents to pass out at the apex of the cell into the surrounding water. A careful investigation has shown that the above three different kinds of cells are merely different stages in the secretory activity of the mucous cells, and that during this activity the cell-contents not only undergo a change of minute structure, but also of chemical composition, the latter being evidenced by the changed reactions which they give with staining agents. During secretion the cell itself is not broken down, but only a portion of its protoplasm is excreted in the form of oily drops and mucous threads, the nucleus remaining intact. Dr. Rawitz considers that special importance must be assigned to the nucleus in connection with the nutrition of the cell, as during the secretory activity of the cell it undergoes changes, not only in its shape, but in its behaviour towards staining reagents.

Striated Muscles in Mollusca.—M. R. Blanchard† thinks that Prof. Fol cannot have fully carried out the proper means of investigating the structures of the muscular tissue of Molluscs, or he would not have denied the presence of striated fibrils.‡ He calls attention to his account of the muscles of *Pecten*, and asserts the accuracy of his observations on the true transverse striation which can be seen in that form.

M. L. Roule§ has reinvestigated the subject and confirms Fol's observation. In muscles which exhibit contractions of some amplitude (e. g. the retractors of the shell), it may be seen that during extension the fibres have their fibrils parallel to their longitudinal axis, while during contractions the fibrils become spirally twisted. Fol's note seemed to indicate that the spiral state was constant, whereas it is only exhibited in contracted fibres. The author suggests that the same state of affairs may possibly obtain in the case of some Annelids and other Vertebrates where transverse striæ have been described.

Molluscoida.

β. Bryozoa.

Nervous System of Phylactolæmatous Fresh-water Bryozoa.‖— Dr. A. Saefftigen has a preliminary notice on the nervous system of these Bryozoa, based on a study of *Cristatella* and *Plumatella*. He finds that the cavity of the supra-œsophageal ganglion is not completely surrounded by nervous elements, for on the side which is turned towards the œsophagus there is endothelium. The nervous elements of the ganglion consist of a cortical layer of cells, bounded externally by endothelium, and inclosing a fibrous mass, which in transverse section is

* Nature, xxxvii. (1887) p. 168, from Proceedings of Berlin Physiological Society, 1887, Nov. 18.

† Comptes Rendus, cvi. (1888) pp. 425–7.

‡ See this Journal, *ante*, p. 199.

§ Comptes Rendus, cvi. (1888) pp. 872–4.

‖ Zool. Anzeig., xi. (1888) pp. 96–9.

horseshoe-shaped. The nerve-fibres of the cornua of the ganglion are traversed pretty regularly by ganglionic cells. The fluid in the cavity does not coagulate on the addition of chemical reagents, contains no morphological elements, and is connected with the body-cavity. The mode of distribution of the tentacular nerves is described in some detail. Direct continuations of the central fibrous mass, in the form of two nerves, innervate the lower part of the body; the hinder part is supplied by a large number of nerves, the distribution of which in the body-wall could not be followed far.

New Genus of Bryozoa.*—Under the name of *Delagia chætopteri*, M. J. Joyeux-Laffuie describes a new and curious Bryozoan, which lives on and in the internal wall of the tube of *Chætopterus*. It is ectoproctous, gymnolæmatous, and stenosomatous, and may be placed among the group Stolonifera of Ehlers. It belongs to the division Orthonemida of Hincks; its stolons recall somewhat those of *Cylindrœcium*, *Victorella*, *Avenella*, or even *Buskia*. In the arrangement of the zoœcia we find some points in common with what is observed in some species of *Bowerbankia;* but a quite special character is given to these zoœcia by the large and apparently spherical vesicle which is found on either side, a little below their orifice. The whole colony is protected by a chitinous and transparent ectocyst.

Polyzoa of Victoria.†—Mr. P. H. MacGillivray continues to publish in the decades of the Prodromus of the Zoology of Victoria figures of Polyzoa; among those lately figured are *Maplestonia cirrata*, *Amphiblestrum albispinum*, *Caberea rudis*, *C. glabra*, and *Schizoporella ridleyi*.

Arthropoda.

a. Insecta.

Nerve-Centres and Sensory Organs of Articulata.‡—M. H. Viallanes commences his fifth memoir with an account of the brain of the Field Cricket (*Œdipoda cærulescens* and *Calopterus italicus*).

Dividing, as before, the brain into protocerebrum, deutocerebrum, and tritocerebrum, he finds that the first consists of the layer of post-retinal fibres, the ganglionic layer, the external chiasma, the external medullary mass, the internal chiasma, the internal medullary mass, the protocerebral lobes, the ocular nerves and ganglia, the pons of the protocerebral lobes, and the median protocerebrum. The first five of these have essentially the same constitution as in insects already described.

The internal medullary mass is formed of three capsules of dotted substance, covering one another, and all three are, by their internal edge, closely connected with the protocerebral lobes. A direct union is established by the commissural cord between the right and left halves.

The two protocerebral lobes fuse with one another in the median line, but only anteriorly and posteriorly; the space between them is part of the median protocerebrum. These lobes are formed of dotted substance invested over a large part of their surface by ganglionic cells.

Immediately behind each of the three ocelli there is a small ocellar ganglion, and from each of these a long ocellar nerve is given off. The

* Comptes Rendus, cvi. (1888) pp. 620–3.

† Natural History of Victoria. Prodromus of Zoology, Decades xiii. (1886) and xiv. (1887).

‡ Ann. Sci. Nat., iv. (1887) pp. 1–120 (6 pls.).

pons of the protocerebral lobes is a narrow band of dotted substance, of a horseshoe shape; by either end it is united with one of the protocerebral lobes, and its substance is invested by ganglionic cells.

The pedunculated body is partially inclosed in the protocerebral lobe; it consists of a calyx, a stalk, an anterior and an internal tubercle; the cavity of the calyx is filled with very small nerve-cells, containing but a small quantity of protoplasm. The median protocerebrum is placed below and between the protocerebral lobes, and consists of a central body, a median lobe, two lateral lobes, and the two tubercles of the central body. The deutocerebrum is situated below the protocerebrum, and is composed of two pairs of nervous masses; it gives rise to four pair of nerves—the antennary, the accessory antennary, the tegumentary nerve, and the root of the stomatogastric ganglion. The tritocerebrum is formed of a pair of lobes, each of which is placed below and in front of the corresponding dorsal lobe of the deutocerebrum.

In the second part of the memoir a comparison is instituted between the brain of Insects and that of Crustacea;* in both there are the same constituent parts, but the protocerebral lobes of Crustacea are widely separated from the median line, and placed in the oculiferous peduncles. As the deutocerebra are similar it follows that the antennary nerve of the Insect is the homologue of the nerve of the antennule of Crustacea. The tritocerebrum of the Insect is, as compared with that of Crustacea, considerably reduced. The nerve of the external antenna is not represented, but the nerves of the labra are homologous. The root of the stomatogastric ganglion of Crustacea is the homologue of the root of the frontal ganglion of Insects, and the stomatogastric ganglion of the former is homologous with the frontal ganglion of the latter. M. Viallanes is of opinion that the head of the Insect is formed of three pre-buccal and three postbuccal "zoonites"; the first carries the eyes and ocelli, the second the antennæ, the third has no appendages but bears the labrum, the fourth carries the mandibles, the fifth the maxillæ, and the sixth the lower lip.

Vision of Caterpillars and Adult Insects.†—Prof. F. Plateau continues his researches on the powers of vision by an investigation of caterpillars and of the frontal ocelli of adult insects.

(1) He made a series of experiments and observations on the caterpillars of fifteen species of Lepidoptera, and obtained the following results:—(*a*) The eyes of caterpillars have a more important rôle than that of simply distinguishing between light and darkness. They really see, though badly. (*b*) The distance of distinct vision is short, and usually about a centimetre. (*c*) At greater distances caterpillars can perceive large masses, but do not discern their nature. (*d*) They only perceive the movements of bodies within the limits of distinct vision. (*e*) Tactile hairs present on the anterior segments of many forms are of much sensory importance. (*f*) The antennæ are much used in testing the path and surrounding objects.

(2) In the next chapter Prof. Plateau discusses the function of the frontal ocelli of adult insects. He gives an historical summary of past researches, describes the manifold conditions of his own observations and experiments, submits tabulated results of his investigations of

* See this Journal, 1887, p. 379.

† Bull. Acad. R. Sci. Belg., xv. (1888) pp. 28–91.

different forms, and formulates the following conclusions. (*a*) Diurnal winged insects, Hymenoptera, Diptera, and Lepidoptera, when blinded by covering the entire eyes with black, or by cutting all the optic nerves, rise to a great height in the air when liberated. (*b*) When the compound eyes are suppressed, but the frontal ocelli left, in Hymenoptera, Odonati, and Diptera, the insects behave exactly as if the ocelli also had been suppressed. When freed, they rise vertically as before. In a chamber lighted from one side they behaved as if they were totally blind. (*c*) But if the frontal ocelli be alone suppressed, the above insects behave as if they had lost nothing. (*d*) In diurnal insects equipped with compound eyes, the ocelli count for almost nothing. They only afford the animals very feeble perceptions which they do not know how to use.

The author concludes his memoir with the following suggestions, which he describes as "plausible hypotheses," supported by a certain number of observed facts:—(1) Diurnal insects, in which all the eyes have been suppressed, still enjoy dermatoptic perceptions. (2) They are almost reduced to the same limitations if the ocelli alone are left at their disposal. (3) The dermatoptic perceptions are the primary cause of the ascending flight of liberated blinded insects. (4) The frontal ocelli serve neither for the perception of movements in adjacent objects, nor for the perception of light in relatively obscure media. (5) The simple eyes, which the author has shown to function in an imperfect fashion in most Myriopods, in many Arachnids, and in caterpillars, have entirely lost their utility in the great majority of insects equipped with compound eyes.

Secretion of Pure Aqueous Formic Acid by Lepidopterous Larvæ for the Purposes of Defence.*—Mr. E. B. Poulton has made observations on the larvæ of the genus *Cerura* (*Dicranura*), which have long been known to have the power of ejecting a colourless fluid from the mouth of a gland which opens on the prothoracic segment. This secretion was found to contain about 33 per cent. of anhydrous acid. A mature larva, which has not been previously irritated, will eject 0·050 grm. of secretion, containing about 40 per cent. of acid. It appears certain, from the chemical investigations that were made, that the secretion consists of a strong aqueous solution of very nearly pure formic acid. The rate of secretion is comparatively slow; starvation lessens its amount, and decreases the quantity of the acid, but this seems to be due rather to the general health than to the acid being formed directly from the food; there was no difference when the larvæ fed on poplar and not willow, or *vice versâ*.

Finer Structure of Butterfly Scales.†—Mr. T. F. Smith regards the scales of *Amathusia* as being very simple in structure; longitudinal ribs run "from end to end of the scale; cross-ribs at regular intervals, and rising from these two or three beads, some of which seem to stand close on the cross-ribs, and some to rise from them with a stalk." In *Morpho menelaus* attention should be given to the contrast between the coarseness of the main structure, and the beautiful minute beads with which it is outlined. In *Papilio memnon* "instead of a single cross-bar at regular intervals connecting the long ones, they are connected by a beautiful interlacing pattern, from which rise numerous minute filaments not more

* Rep. Brit. Assoc. Adv. Sci., 1887 (1888) pp. 765–6.
† Journ. Quekett Micr. Club, iii. (1887) pp. 178–81.

than the 100,000th of an inch in diameter." In *Zygæna trigonilla* the structure is quite different; there is no trace of cross-ribbing, but from the inner part of the membranes of the scale Mr. Smith thinks a tufted structure springs, which in appearance is not unlike the hairs on the leaves of some plants.

Scent-organs of German Lepidoptera.*—Prof. P. Bertkau has continued his observations on the scent-organs of various German Lepidoptera. The Noctuina have ventrally placed organs of the Sphingid type. In *Hadena* and *Dichonia* the hairs of the tuft are extraordinarily long; there is not, as in the Sphingidæ, one scale on one large gland-cell, but several smaller cells belong to one scale. A very similar apparatus was found in some Orthosiidæ. It is somewhat remarkable that homologous organs should be found in groups which are, systematically, so wide apart as the Sphingidæ, Noctuina, and Geometridæ.

Scent-glands of Phryganidæ.†—Dr. W. Müller has been confirmed in his opinion that the peculiar palpi of *Sericostoma personatum* were comparable to the scent-glands of Lepidoptera by the discovery that they are confined to the male. Instead of the four elongated joints of the maxillary palp which are found in the female, the male has a single terminal joint formed by the fusion of several joints; this is almost spoon-shaped, the edge which is turned away from the head is widened; on the other side the spoon lies so close to the head that it seems to form part of it, and covers it like a mask; by this means the secretion appears to be protected from evaporation. The interior of the spoon is quite filled by very fine hairs, which are pale, faintly knobbed, and about one millimetre in length. When the palpi are separated the hairs become spread out.

The secondary sexual organs which have been observed in various Phryganids, such as *Notidobia*, *Drusus*, and *Grumicha*, are probably also scent-organs.

Development of Endoderm of Blatta germanica.‡ — M. N. Cholodkovsky has undertaken the reinvestigation of the origin of the endoderm. The endoderm in *Blatta germanica* does not become differentiated until after the closure of the primitive groove, the appearance of rudiments of the appendages, and the beginning of the differentiation of two nerve-trunks from the ectoderm. The inner of the two constituent layers of the embryo breaks up into two rows of hollow mesodermal somites; the cells of the inner median wall of the somites become distinctly differentiated into two layers, the thicker of them form the mesodermal enteric wall, while the other gradually separates itself from the wall of the somite, lies close to the nutrient yolk, and forms the true endoderm, which, later on, completely incloses the yolk. The yolk-cells take no part in forming the endoderm, and appear to be provisional phagocytes in the histolysis of the nutrient yolk.

The late appearance of the endoderm of *Blatta* is intelligible when we consider the extremely small part which it plays in the structure of the complete insect, in which the greater part of the organs are of ectodermal origin.

* Verh. Nat. Ver. Preuss. Rheinlande, xliv. (1887) pp. 118–9.
† Arch. f. Naturgesch., li. (1887) pp. 95–7.
‡ Zool. Anzeig., xi. (1888) pp. 163–6.

Comparative Biology of Necrophagous and Coprophagous Dipterous Larvæ.*—Baron Osten-Sacken has a report on Mr. Portchinski's observations on the life-history of various dipterous larvæ. Referring to the well-known fact that the larvæ of various widely separated species can scarcely be distinguished from one another, he points out that this is a result of adaptation to their modes of life. The larvæ of *Calliphora erythrocephala*, *Lucilia cæsar* (which are Muscinæ), and *Cynomyia mortuorum*, which is a Sarcophaginid, are almost indistinguishable. The coprophagous larvæ, which are found in very various families, all show a tendency to shorten as much as possible the period of development, and in many cases they are viviparous. The comparative ease with which the course of development may be modified is shown by *Musca corvina;* in the north of Russia this species lays twenty-four eggs, and the larvæ omit the second stage of development; in the south of Russia the same species has the same history in spring only; towards the end of spring and in summer it lays only a single very large egg, which, on extrusion, passes at once into the third stage.

All the various modes of development, which result in as rapid an acquirement as possible of the imaginal stage, are regarded by Mr. Portchinski as the consequence of the coprophagous mode of life of the larvæ. The large number of such forms are found together on food-areas which are often small, and this causes the animals to complete their developmental stage as rapidly as possible. With this is connected a small degree of fertility.

That *Musca domestica* (the common housefly) should afford an exception by laying a large quantity of eggs (120–160), and by its larvæ passing through all three stages, may be explained by its having become a domesticated animal, which is not exposed to the same struggle for existence as are its allies.

Organization of Brain of Somomya erythrocephala.†—Dr. J. Cuccati has a contribution to our knowledge of the structure of the brain in insects. In the brain of *Somomya* he finds that the olfactory-optic-bundle of Bellonci is present, together with the bundle which connects the antennary swellings with the fibrous plexiform substance of the head of the fungiform body; there, too, is the crossed olfactory-optic-bundle of the same author. The antennary swellings are connected with one another by two large and by intermediate smaller commissures. The antennary nerves consist of fine outer and larger inner fibres; they are connected by nerve-fibres with the central stalk, and with the motor nerves of the labium. The optic swellings are likewise connected by commissures with one another. They give off a crossed bundle, the fibres of which pass into two plexiform masses; they are directly connected with the anterior cerebral masses and with the hinder masses of the cerebral spheres.

In the brain there are a larger number of commissures placed in different planes; there are also crossed bundles, which arise from the cells in the median line, and these send off fibres in the direction of the optic swelling. As in the Orthoptera there are two bundles, one of which arises from cells and the other from the plexiform mass; the former serves to supply the proboscis, and the latter passes into the

* Naturforscher, xxi. (1888) pp. 66–7.

† Zeitschr. f. Wiss. Zool,, xlvi. (1888) pp. 240–69 (2 pls.).

stalk of the brain, of which only one is present. The nerve of the stemmata has both fine and strong fibres; the former probably pass, as in the Orthoptera, into the fork-shaped body, but the latter go to the hinder part of the brain. Groups of cells send out processes into the fan-shaped body, and into the "body of elliptical section." Other groups in various parts of the brain send out processes in various directions, according to the position which they occupy.

Machilis maritima.*—M. S. Jourdain has a preliminary note on this Thysanurid, in which he limits himself to an account of the thoracic and abdominal appendages, and of the curious exsertile vesicles of this animal. Externally to the coxa there is an articulated piece which the author compares with the exopodite of a crustacean appendage; if this view be correct, the thoracic appendage of a *Machilis* may be said to be composed of a basal piece which carries an endopodite and an inarticulate exopodite. The abdomen is formed of eleven, and not, as is generally stated, of ten rings; the first has no appendages; the seven that succeed carry a pair of delicate and short appendages, consisting of a very reduced basal piece, and a longer joint which ends in a single unguis. The appendages of the ninth ring are more developed, and these are the organs which, by separating sharply, form the leaping organs. Those of the tenth ring are modified with long, sebaceous, and multi-articulate filaments; while the last ring has one such appendage, which may be supposed to be formed by the fusion of two. The possession of these abdominal limbs causes the author to regard *Machilis* as intermediate between Insects and Myriopods.

To get a good view of the exsertile vesicles which are found on the inferior surface of the abdomen, it is necessary to place the animal in a glass tube, the inner wall of which has been moistened; it may then be seen to suddenly protrude twenty-two vesicles, which have the form of small oblong sacs, distended by liquid. These organs, which appear to correspond to the abdominal vesicles of certain Podurids, are arranged in two longitudinal rows on either side of the middle line. They are formed by a portion of the integument of the abdomen, which is delicate and membranous, is invaginated when in repose, and when distended by the liquid of the general cavity is evaginated suddenly on contact with a moistened surface. It is possible that they are organs which absorb the water which is necessary to make up for that lost by the animals when running over surfaces exposed to the rays of the sun.

Brain of Phylloxera.†—M. V. Lemoine pursues his researches on the nervous system of the winged *Phylloxera punctata*, and has made sections of its brain. He describes the structure of the ocelli and their innervation, the optic lobes, and the innervation of the compound eyes. The author gives an intimate account of the various divisions of the brain, the different commissures, the subœsophageal, and other ganglionic masses.

β. Myriopoda.

Brain of Iulus.‡—M. G. Saint-Remy has examined the internal structure of the brain of *Iulus sabulosus*, and *I. maritimus*. The organ is divisible into three ganglionic regions, the optic, the antennary or

* Comptes Rendus, cvi. (1888) pp. 623–5.
† Ibid., pp. 678–80.
‡ Ibid., pp. 618–20.

olfactory, and the mandibular. The first of these is divisible into two regions, the median optic ganglion which occupies the posterior and superior part of the brain, and the optic lobes which lie laterally and correspond to the optic ganglia of Insects and Crustacea. The former portion is interesting in two points; in the middle of the cortex of ganglionic cells there are two islets of small nuclei grouped around an eminence of the medullary substance; these have all the characters of the ganglionic nuclei of Dietl, and may be considered as cells which are very poor in protoplasm. The optic lobes are small cylinders situated at the extremities of the brain; though their structure is somewhat complicated, it is much simpler than that of the optic ganglia of Insects; each consists of four layers, internal medullary, layer of optic fibrils, ganglionic layer, and layer of optic bundles.

The olfactory ganglia are formed by the two olfactory lobes, each of which consists anteriorly of a thick layer of ganglionic nuclei, below which the dotted substance is peculiarly fine and homogeneous. On the outer side the lobe is swollen into a lobule invested by ganglionic cells, in which the dotted substance is differentiated into glomeruli comparable to those of Insects. The mandibular ganglion, which is situated in the inferior and anterior part of the brain, is formed of two lobes united behind by a commissural band, and in front by a well-isolated nervous bridge which gives off the stomatogastric nerves. Its ganglionic cortex consists only of cells rich in protoplasm. The nervous bridge is formed of a cylinder of dotted substance invested by large cells. There is a transverse commissure of the œsophageal ring, which is formed by a bundle of fibres that take a U-shaped course.

We may conclude that the brain of *Iulus* is more complicated than that of other Myriopods yet studied by M. Saint-Remy, and that it presents striking resemblances to that of Insects; there are traces of the pedunculated body; the optic ganglion, though complex, has no chiasma; the olfactory lobe is relatively more important than that of Insects, as in them there are cells poor in protoplasm which are specially reserved for the centres of special sensibility.

γ. Prototracheata.

Development of the Cape Species of Peripatus.*—Mr. A. Sedgwick continues his account of the development of *Peripatus* of the Cape from stage G to birth. The changes which take place are mainly those of growth and histological differentiation. The segmented thickenings of the ectoderm which are called the ventral organs are, in the first segment, probably represented by the cerebral grooves; those of the second differ from all the posterior in not coming into contact with one another in the mid-ventral line; they remain in the ectoderm and appear to retain a connection with the posterior lobe of the brain; the ventral organs of the oral papillæ become divided into two parts by the lips; those of the seventeen ambulatory legs appear to retain a cellular connection with the lateral nerve-cords. The ventral cords withdraw from the ectoderm, though they still appear to be attached to the latter by marked cellular processes. The changes in the nervous system and eye are described. The crural glands seem to be entirely derived from the ectoderm, but nothing is known as to the details of their development.

* Quart. Journ. Micr. Sci., xviii. (1888) pp. 373–96 (4 pls.).

The endoderm in stage G becomes reduced to a layer of extreme tenuity; soon, however, it begins to increase in thickness; the endodermal part of the alimentary canal is without glandular appendages of any kind.

The mesoderm may be considered under four heads:—

(1) The muscles of the skin arise from the subectodermal fibrous network, the outer part of which becomes arranged in a circular manner, and so forms the circular muscles of the body-wall; the longitudinal muscles arise in seven patches. The contractile tissue of the gut-wall and internal organs generally is derived from wandering cells, which themselves appear to be derived from the walls of the mesodermal somites.

(2) The body-cavity is vascular in type, and may, as Lankester suggests, be called the "hæmocœle." The heart, in stage G, becomes a tube with thin walls and flattened nuclei, lying freely in the pericardial cavity, with cellular cords projecting from its walls into the latter; these cords seem to become transformed into a pericardial network, which contains round nuclei in its nodes, and is continuous with the floor and roof of the pericardium. The hæmocœle becomes divided into five main chambers—central compartment of the body-cavity, heart, pericardial cavity, two lateral compartments in which the nerve-cords and salivary glands lie, and the leg-cavities which contain the nephridia.

(3) Mr. Sedgwick recapitulates the history of the nephridia under the head of the somites from which they are respectively derived.

(4) The generative organs, in stage G, form two tubes lying in the central compartment of the body-cavity, and closely applied to one another in the middle line. The generative ducts may be regarded as modified nephridia.

It is commonly said that, in the Arthropoda, the generative ducts are continuous with the glands, but in *Peripatus*, at any rate, they present exactly the same relation to the gonads as do the oviducts of the dogfish or the earthworm to the ovaries of these animals; or, in other words, the generative ducts open into the cœlom, and the ova are products of the cœlomic epithelium.

Not only has *Peripatus* nephridia, but the coxal glands of *Limulus*, and the antennary glands of Crustacea are, as Lankester has suggested, probably nephridia; so that the negative feature often regarded as characteristic of Arthropods—the absence of nephridia—can no longer be considered as justified by the facts of the case.

Development of a South American Peripatus.*—Mr. W. L. Sclater has an account of the early stages of development of a South American species of *Peripatus* from Demerara, which he proposes to call *P. Imthurmi*. The egg is small, as in *P. torquatus* and *P. Edwardsii*, and there is an "extraordinary discrepancy" between its early stages and those of *P. capensis*. The segmentation is complete, and there is no appearance of sponginess, such as is described by Sedgwick for *P. capensis*, nor would one suppose from the nature and size of the ovum that it had only comparatively recently lost its yolk. The only similar case known to us is that of placental mammals, and in both cases there appears to have been diminution in the size of the ovum, total segmentation, and the formation of an embryonic (*Peripatus*) or blastodermic (mammals) vesicle.

A curious phenomenon, of which the author can offer no explanation,

* Quart. Journ. Micr. Sci., xxviii. (1888) pp. 343–63 (1 pl.).

is the apparent inversion of the layers, for the epidermis appears to be formed from the inner layer of cells, and the hypoblast from cells that are, morphologically speaking, part of the outside layer of the embryo; the cause may perhaps be found in the so-called amnion.

The species of *Peripatus* appear to fall into three groups: New Zealand species, Cape species, and South American species. The only anatomical difference between the two latter which is of importance is the presence of a receptaculum ovorum, or closed vesicle, between the ovary and the receptaculum seminis. The only other instance of great variation in development which the author remembers is that of Bateson's *Balanoglossus* and the ordinary *Tornaria-Balanoglossus;* but that difference is explicable by the difference in habit, for the former is mud-living and the latter is pelagic. But, with *Peripatus*, the habits and mode of life seem to be much the same wherever they occur, so that the striking differences in development cannot be explained by change of habits modified by external conditions.

δ. Arachnida.

Eyes in Scorpions.*—Mr. G. H. Parker finds that the retinæ of the median and lateral eyes of scorpions are hypodermal in origin. The median eye is found to be triplostichous, and to be formed by an involution of the hypodermis and an inversion of the middle layer; the first layer (lentigen) is modified hypodermis immediately external to the pocket of involution; in addition to secreting the lens, it serves the purpose which gained for it its earlier name of vitreous. The lens differs from ordinary cuticle in having no pore-canals, and, except the external hyaline layer, it can be stained throughout. The lentigen can produce cuticula independently of the general hypodermis. The second layer, or retina, is inverted, and consists of nerve-end-cells and pigment-cells; it contains phaospheres. The walls of the nerve-end-cells are thickened into prenuclear rhabdomeres, and a nerve is given off from their deep ends; five rhabdomeres unite to form one rhabdome. Each pigment-cell forms two sacs, connected by a stiff fibre; the nucleus is in the inner one. The third or post-retinal layer is the "sclera matrix" of Graber, and it becomes intimately fused with the retina. In the embryo the fibres of the optic nerve emerge from the external ends of the inverted retinal cells, but in the adult from the opposite ends. The basement membrane is a cuticula formed by the inner ends of the hypodermal cells; the preretinal membrane is the united basement membranes of the lentigen and retina; the sclera is the basement membrane of the post-retina.

The lateral eyes are monostichous, and arise from a simple thickening and depression of the hypodermis; around the margin of the depression is a ring of perineural cells which secretes the lens; they differ from the lentigen in not having a vitreous function, owing to subsequent recession removing them from between the lens and retina. The lens has the same structure as in the median eye, but the retina wants the phaospheres; there is no preretinal membrane. Mr. Parker thinks that the lateral eyes may well be supposed to represent the ancestral type of the median eyes.

So-called Auditory Hairs.†—Herr W. Wagner has investigated the nature of the hairs which Dahl described as "auditory." He distin-

* Bull. Mus. Comp. Zool. Camb., xiii. (1887) pp. 173–208 (4 pls.).
† Bull. Soc. Imp. Nat. Moscou, 1888, pp. 119–34.

guishes two types of hair, one in which the cuticular root-portion is thick compared with the free stem, a second in which the root is the more delicate portion. The first or tactile hairs are described at length and contrasted with the second or protective hairs. As to those hairs which Dahl described as auditory, two types occur, and minor variations besides. They are not uniform structures. A very distinct third type, swollen in a cucumber-like expansion, was observed by the author on a species of *Mygale* brought from New Guinea by Korotneff. The three forms are very carefully described, but the details can hardly be compressed. It is more important to notice Herr Wagner's conclusions: — (1) That the functions of the types described cannot be supposed to be identical; (2) that no one of the types can be recognized as auditory.

What, then, is their function? They are more perfect and more sensitive than the ordinary tactile hairs. They can be affected by slight agitations which do not influence the latter. Herr Wagner is convinced that their rôle is to perceive finer sensations, such as those which indicate the approach of rain. Thus it is intelligible why the vagabond forms should have these hairs in much richer abundance than the sedentary forms, in which (e.g. in Epeiridæ and Theridiidæ) they occur only on the tibia and the metatarsus.

New Orb-weaving Spider.*—Dr. H. C. M'Cook has discovered in Florida a new orb-weaving spider, which he calls *Cyrtophora bifurca*. Though with some resemblances to *C. caudata* of Hentz, it differs entirely in the shape of its cocoon, for this is of a somewhat irregular octagon shape, and is of a light-green colour. The number of cocoons found on one string varied from ten to fourteen; they are bound together by continuous series of thick white threads, which extend from the top to the bottom of the string. Within each cocoon, which consists of two parts, there is a very slight tuft of flossy white silk, in which the eggs are deposited. The spider is of about the shade of its cocoon; the female is most remarkable for the cleft at the apex of the conical prolongation of the abdomen.

British Oribatidæ.†—Mr. A. D. Michael has published the second volume of his admirable monograph of the British Oribatidæ. An amended table is given of the genus *Tegeocranus* and the genera *Notaspis* (with nineteen species), *Damæus* (with eight), *Hermannia* (with six), *Eremæus* (with two), *Nothrus* (with thirteen), *Hypocthonius* (with four), and *Hoplophora* (with five), are described in detail. An amended table, with descriptions of two new species, is also given of *Scutovertex*. A few nymphs whose adults were included in the first volume are described, and supplementary notes are made on other species.

The author considers the classifications recently proposed by Canestrini and by Berlese, and makes some emendations of his own earlier classification, the most important of which is the reduction of the monodactyle and tridactyle distinction to specific instead of generic value, in consequence of the discovery of some monodactyle species of *Nothrus*. It will be remembered that Mr. Michael made use of this means of distinction with some reluctance.

* Proc. Acad. Nat. Sci. Philad., 1887, pp. 342-3.

† British Oribatidæ, ii. (Ray Society's vol. for 1887), London, 1888, pp. i.-xi. and 337-657, pls. xxv.-liv.

There is an interesting chapter on anatomy. The author is more strongly than ever of opinion that the so-called stigmata are sense-organs. Some additions are made to the account of the mouth-organs. Coition probably takes place by a bursa copulatrix within the anal plates and in immediate proximity to the anus, and not at the vulva of parturition within the genital plates. Mr. Michael finds that there is not in every species a complete breaking-up or dissolution of all the organs of the nymph prior to the formation of the adult; in some cases, at all events, some of the internal organs of the nymph are transferred to the adult, and are not dissolved, but are identical in both stages. Where dissolution and reformation have occurred in the specimens observed by the author, the two processes have gone on simultaneously, and there has not been any time when the cuticle contained only plastic or liquid matter without any organs. In the earlier stages of this change the contents of the nymphal skin have, in such cases as were observed, shrunk backward towards the posterior portion of the creature, leaving the cuticle of the rostrum, &c., empty, while the contents of the legs have been withdrawn or shrunk inward into the body-substance, leaving the cuticle of the legs empty. In the later stages of formation the organs of the adult have again advanced forward nearer to the rostrum of the nymphal cuticle, but not as far forward as the old organs originally were.

A list is given of foreign species of Oribatidæ, and the work concludes with a bibliography. There is a copious index.

c. Crustacea.

Palpiform Organs of Crustacea.*—Prof. F. Plateau continues and concludes his series of studies on the function of palps in Arthropods by an investigation of the palpiform organs in Crustaceans. In an introductory discussion of the homologies between the appendages of Crustaceans and those of other Arthropods, he concludes (1) that neither the pseudopalp of the mandible nor the so-called palps (exopodites) of the three pairs of maxillipedes are homologues of the palps of insects, and (2) that the real homologues are to be found in the *endopodites* of the two pairs of maxillæ and of the three pairs of maxillipedes.

He then gives an account of his observations and experiments on the following forms in order:—*Talitrus saltator* Montagu, *Gammarus pulex* Linn., *Porcellio scaber* Latr., *Oniscus murarius* Cuv., *Ligia oceanica* Linn., *Asellus aquaticus* Linn., *Carcinus mœnas* Baster.

His results on crabs disprove, he believes, (1) the opinion of Brullé, Milne-Edwards, and Claus, that the maxillipedes of Crustaceans are used in seizing food, and in conveying it between the other buccal parts. This is quite erroneous as regards the Brachyura. The external maxillipedes are merely auxiliary in retaining the food seized by the claws and under the action of the mandibles. (2) The hypothesis of Milne-Edwards and Huxley that the external, and probably also the other pairs of maxillipedes, as well as the maxillæ proper, are of use in mastication, is not true of crabs. There the mandibles alone are masticatory. (3) The function suggested by Dugès and Rolleston that the mandibular palp is used to direct the food, is not supported by any observed facts. In crabs it can be readily observed to have no such rôle.

* Bull. Soc. Zool. France, xii. (1888) pp. 537–52 (11 figs.).

The palps of masticating insects, female Aranciдæ, and Chilopod Myriopoda, represent degenerate appendages, without definite function, all but useless, and readily dispensed with. The same may be said of many of the palpiform organs of Crustaceans, since Isopods and Amphipods, deprived of the endopodites of their maxillipedes, seem to get on just as well. Finally, the exopodites (miscalled palps) of the maxillipedes of Decapod Crustaceans do not share at all in the prehension of food or in its introduction into the mouth.

Abbreviated Metamorphosis of Alpheus, and its Relation to the Condition of Life.*—Mr. F. H. Herrick has discovered a Bahaman species of *Alpheus* (*A. præcox* sp. n.) in which the animal acquires all its adult characters in twenty-four hours after hatching. Some interesting data are afforded by the subjoined table:—

Species.	Habitat.	Metamorphosis.	Number of Eggs.	Diameter.	Length of ♀
A. minus	Shell heaps and exhalent oscula of sponges	Complete	500–600	1/35 in.	1/2–1 in.
A. heterochelis ..	Do.	Abbreviated	200–300	1/28 in.	1½ in.
A. præcox ..	Interior of sponges	Nearly lost	5–350	1/24 in.	1/6–1⅔ in.

It is now generally agreed that the zoëa of Decapod Crustaceans is not a primitive form, but one gradually acquired as the habits of the larva diverged from those of the adult. When, therefore, the habits of the adult or larva tended to converge, the zoëal stage would be shifted to the egg. The fact that of the numerous species of *Alpheus* only two are known to undergo an abbreviated development is evidence of the extreme plasticity of young animals, and of their tendency to vary with varying conditions of life.

Reproduction of Lost Parts.†—Mr. G. Brook gives an account of his observations on the reproduction of lost parts in the common lobster. A brief résumé of the history of previous observations is given. The reproduction of the chelæ, walking legs, and antennæ is described, and their rates of growth are noted. It seems probable that limbs lost in summer are reproduced more rapidly than those lost in winter. The author describes the deposition of pigment in the new appendages, and notices finally, in regard to the rupture of the carapace during ecdysis, that the cephalothorax splits along the dorsal suture in some cases, but certainly does not do so in others.

Parasitic Castration in the Eucyphotes of Palæmon and Hippolyte.‡—M. A. Giard has recently collected evidence which supports his view that male *Palæmons* appear not to harbour *Bopyri*, because the atrophy of the testes in the infected males produces, as a consequence, an arrest of the external sexual characters. Reference is made to the secondary sexual characters in *Palæmon*, indicated by Grobben and

* Johns-Hopkins Univ. Circ., vii. (1888) pp. 34–5.
† Proc. R. Phys Soc. Edin., ix. (1887) pp. 370–85 (1 pl.).
‡ Comptes Rendus, cvi. (1888) pp. 502–5.

J. v. Boas, as well as other points. As in previously studied cases of castration, there is a very singular want of uniformity in the phenomena observed, which is probably due to the date at which infestation occurred; and the modifications are not indelible, for in male *Paguri*, which had been freed from their parasites, the characters of the male sex gradually reappeared at the successive moults. The numerous species of *Hippolyte* have been described in a way that leads M. Giard to suppose that the castrating influence of parasitism has not been taken into account.

Fresh-water Crabs of Africa.*—M. A. Milne-Edwards finds that the fresh-water crabs of Africa are all Thelphusidæ; twenty-five species are enumerated; for a form from Lake Tanganika, a new genus—*Platythelphusa*—is instituted. The species is called *P. armata*.

Photospheria of Nyctiphanes norvegica.†—Messrs. R. Vallentin and J. T. Cunningham have investigated the structure of the phosphorescent organs of this Schizopod. They find that the hinder part of each organ is bounded by a layer composed of wavy fibres, which, to some extent, anastomose; this layer is of considerable thickness, and forms a hemispherical cross, open in front only. It contains no distinguishable cell-areæ, and, as it resembles to some extent a tapetum, it may be called the reflector. The external surface is covered by a flat mosaic-like epithelium of polygonal, red pigment-cells. Internally to the reflector is a layer of large cells, each with a large nucleus; the internal surface of the cellular layer is perfectly smooth, and in the hollow contained by it is a curious fibrillar mass. The fibrils of this are mostly straight, and those that are external are perpendicular to the surface of the cellular layer, while the core consists of two bundles of straight fibrils which cross at right angles, and other bundles set in other directions. In front of the fibrillar mass are a few flat cells, which belong to the cellular layer, and in front of these is a bi-convex lens; this is perfectly homogeneous and highly refringent, and, as its diameter exceeds that of the fibrillar mass, it rests on the edges of the cellular layer. In front of the lens is a layer of cellular tissue, which contains a ring of circular fibres, running round the edge of the lens. The cells of this layer, which may be called a cornea, are much smaller and more regular than those of the posterior cellular layer. The differences between the photospheria of the body, which have just been described, and that of the ocular peduncle is considerable; in the latter, every layer, with the exception of the straight fibrils and the reflector, is continuous with the epidermis. This would appear to indicate that the organ is formed by differentiation of parts from a simple thickening of the epidermic layer of cells. The reflector is probably a specialization of subepidermic mesoblastic tissue, and the posterior cellular layer a specialization of the deepest portion of the epidermic thickening. The other photospheria are advances in specialization.

With regard to the function of these organs, the authors admit, with reservation, that their activity is under the control of their possessor; nothing like continual luminosity was ever observed. When an animal was crushed beneath the fingers certain particles were luminous, and remained so till they were dry. When crushed under a cover-glass it

* Ann. Sci. Nat., iv. (1887) pp. 121–49 (3 pls.)

† Quart. Journ. Micr. Sci., xxviii. (1888) pp. 319–41 (1 pl.).

was found possible to separate all the component layers from one another. The internal surface of the reflector was the only part that was not perfectly transparent; it, with transmitted light, glowed with a beautiful luminous-looking rosy-purple colour. When the light was cut off it was yellowish-green. This colour was found to be due to fluorescence, and not to a pigment.

A comparison of the photospheria with other luminous organs presents few points of resemblance. All that can be said is that the cells of the cellular layer are similar in general appearance to the cells of the luminous layer in *Lampyris splendidula*, and that some or other of the cellular elements in the luminous organs of fishes are the active light-producing agents. The cells of *Nyctiphanes* may be really the active agents in emitting light, and the fluorescent surface of the stratified layer only an accessory adjunct.

New Commensal Amphipod.*—MM. E. Chevreux and J. de Guerne describe a new amphipod (*Cyrtophium chelonophilum*), which was found commensal on the marine tortoises (*Thalassochelys caretta*), living near the Azores. The new species differs from forms already known by the shortness of its antennæ; it resembles *C. lævc* in the smoothness of the upper part of its body, but differs by its shorter head. Its mode of life is like that of *C. parasiticum*, which lives commensally with a large Holothurian in Port Jackson. In previous records of crustaceans living on tortoises there has never been sufficient evidence to show that their presence was not accidental, but in the case of the present species the habit has been noticed by Prince Albert of Monaco in 1885, and by one of the writers in 1887, while in the latter instance seventy-seven specimens were found.

Apseudes and the Tanaidæ.†—Prof. C. Claus has contributed a detailed account of the structure of *Apseudes latreillii* Edw., both in itself and in relation to the Tanaidæ. He emphasizes the relationships which the Anisopodæ (Tanaidæ and Apseudidæ) exhibit, on the one hand with the Cumaceæ in the Thoracostraca group, on the other hand with the Isopoda among the Arthrostraca. In expressing the contrast between Thoracostraca and Arthrostraca, the Anisopoda should be recognized as an order correlated with the Isopoda.

The Trieste species of *Apseudes* is probably *A. latreillii* Edw. The British form with the same title (Spence Bates and Westwood) is quite different. (*a*) There is no ventral joint between the first and second thoracic segment; they are fused. A minimal trace of the ventral myomere remains as a rudiment, though the joint has quite disappeared. (*b*) The brain most nearly resembles that of Isopods (*Sphæroma*), and consists of fore-brain, with central ganglia and lateral eye-ganglia, of the somewhat ventral middle portion with one large ganglion and nerves for the first pair of antennæ, and of the hind portion extending over the œsophageal ring, and including ganglion and nerves for the second pair of antennæ. Besides the anterior and posterior commissure, there is, on the œsophageal ring, a marked transverse commissure, which is in relation with the ganglia of the second pair of antennæ. There is a nerve-ring on the upper lip with unpaired ganglia, as in *Branchipus* and the Phyllopods. The ventral chain consists of a sub-œsophageal portion, with four distinct pairs of ganglia for the mandibles, maxillæ, and

* Comptes Rendus, cvi. (1888) pp. 625–8.

† Arbeit. Zool. Inst. Univ. Wien, vii. (1887) pp. 139–220 (7 pls.).

maxillipedes, of seven pairs of ganglia in the thorax, and of six pairs in the abdomen, of which the last is due to two or more. The anterior side of the gizzard bears a large sympathetic ganglion, with two lateral nerves. (*c*) The eye is without corneal facets or crystalline cones. It contains in its pigment-mass eight retinulæ. Each of these consists of a 7-partite rhabdom and seven nerve-cells running out into nerve-fibres. The retinal ganglion lies on the lateral edge of the large optic ganglion. (*d*) Delicate plumose bristles occur on the metacarpal joint of the six thoracic appendages on both pairs of antennæ, and on the dorsal surface of the anal segment. The stalks of the bristles are protected by cuticular capsules. (*e*) The structure of the mouth is then described, with notice of the two glandular sacs on the epipharyngeal wall, &c. The stomach essentially resembles that of the Diastylidæ, and presents close analogies with that of Decapods. The pyloric portion, with its pouches and tongue-shaped valve, is no sieve, but retains the food for further digestion. There are three pairs of digestive glands. The hind-gut has no special features. (*f*) At the base of the second pair of antennæ lie the rudimentary antennary glands. Urates occur in the fatty body in the abdominal and posterior thoracic segments. (*g*) The shell-gland is represented by two coiled canals, with a central sac and lateral efferent duct, which opens on an elevation at the base of the second maxilla. The shell-gland is also present in various Isopods. In the Diastylidæ also it has a ventral maxillary position. (*h*) The upper lip is filled with a group of glandular salivary cells, opening by pores. Quite different are the skin-glands, found especially on the two first pairs of appendages. They consist of two pyriform apposed cells, and of a third serving as duct and opening by a pore. (*i*) The heart is like that of *Tanais* and *Leptochelia*. There are only three ostia, though two pairs are present in the embryo. Besides the cephalic aorta and the two abdominal arteries, three pairs of arteries were distinguished in the fourth, fifth, and sixth thoracic segment. A transverse septum divides the body-cavity into a pericardial sinus and a ventral blood-space, in which gut, digestive gland, reproductive organs, and ventral nerve-chain are contained. (*j*) The reproductive rudiments are represented by a few cells in the fourth thoracic segment, above and somewhat to the side of the gut. The ovarian rudiments grow gradually into long tubes. Generative apertures in the female are seen only in the stage of brood-sac formation, as narrow clefts on the fifth thoracic segment. The testes always remain as simple pear-shaped sacs in the fourth thoracic segment, and give off a long narrow vas deferens, which opens on the posterior margin of the seventh thoracic segment, on the median spine, which serves as a copulatory organ.

New Parasitic Copepod.*—Mr. I. C. Thompson describes a new species of *Lichomolgus*, *L. sabellæ*, which was found attached to the gill-filaments of a *Sabella* from Beaumaris, North Wales. The posterior antennæ are four-jointed and very powerful, the second joint being provided with four small curved hooks and the apical with four large strong hooks.

New Cirriped.†—Dr. W. Weltner found among the thirty-one species of Cirripeds collected during the voyage of the *Prinz Adalbert*

* Sci.-Gossip, 1888, pp. 32–3 (4 figs.).

† Arch. f. Naturgesch., li. (1887) pp. 98–117 (2 pls.).

a new species of *Acasta*, which he calls *A. scuticosta*, and of which he gives a full description. It is distinguished from *A. undulata* by the less broad crest of the tergum.

New Crustacean Parasite.*—The Rev. Dr. A. M. Norman describes a remarkable new parasite allied to Lacaze-Duthiers' *Laura*. Like it, *Synagoga mira* (g. et sp. n.) is parasitic on an Antipatharian, *Antipathes larix*, but it differs in position, for *Synagoga* is external to its host. Other differences are that the valves of *Synagoga* are shorter than its body; the antennæ are strongly developed grasping organs, the hinder limbs are two-branched, jointed, and freely setose, and the laminæ of the caudal furca are much longer, spined on the edges, and provided with long setæ. *Synagoga* appears, therefore, to be much less retrograde than *Laura*. Of its relations Dr. Norman contents himself for the present with saying that there is much in its structure to remind us of the Cypris-condition of a larval Cirriped, and other features which strongly recall the much-disputed genus *Nebalia*.

Vermes.

a. Annelida.

Formation of Tube of Annelids.†—M. A. Soulier's observations on the mode of formation of the tube of *Myxicola* do not confirm the generalization of Claparède. This worm produces a filament of mucus which escapes from the branchial funnel; this falls by its own weight, and is afterwards taken up by the branchiæ and cast out. In no case does this mucus take part in forming the tube. While it is being secreted the animal is being very rapidly enveloped in an independent mucous tube. If a *Myxicola* be cut below the tubiparous glands the hinder part of the body continues to secrete mucus in great abundance, and a worm deprived of its tubiparous glands can surround itself with a mucous tube in a few minutes. *Branchiomma* behaves in the same way. In both cases the tube is due to the secretion of isolated mucous glands, scattered irregularly over different parts of the surface of the body. These glands form accumulations near the feet and on the ventral surface. The author promises an account of them in a short time.

Cardiac Body of Annelids.‡—Dr. R. Horst has a note on the recent observations and criticisms of Mr. J. T. Cunningham. He thinks that his views and interpretations have been too severely attacked, and he urges certain historical considerations which his critic appears to have neglected.

Monograph of the Capitellidæ.§—In this large monograph Dr. H. Eisig does not confine himself to the description of the species that compose the group Capitellidæ, but discusses many points of great morphological importance.

In the first part the anatomy and histology of *Notomastus, Dasybranchus, Mastobranchus* g. n., *Heteromastus* g. n., *Capitella*, and *Capitomastus* g. n., are described under the heads of general form, integument,

* Rep. Brit. Assoc. Adv. Sci., 1887 (1888) p. 86.
† Comptes Rendus, cvi. (1888) pp. 505–7.
‡ Zool. Anzeig., xi. (1888) pp. 135–8.
§ Fauna u. Flora des Golfes von Neapel, Monogr. xvi. (1887), xxviii. and 906 pp. (37 pls.).

musculature, enteric canal, central nervous system, sensory organs, parapodia, respiratory organs, nephridia, generative organs, cœlom, and hæmolymph. The second portion is morphological and comparative. Among the cuticular structures which are discussed are the segmental spinning glands of *Polyodontes*, the hairs of *Aphrodita aculeata*, the glandular pouches of *Polydora* and *Spio bombyx*, the tubular glands of *Owenia filiformis*, the coiled tubes of the Nereidæ, *Sphærodorum* and *Phyllodoce*, the secretions of *Typhloscolex*, and of the hypodermal cells of *Phyllochætopterus* and *Ranzania*. Comparisons are then instituted with the skeleton of horny sponges, the stinging organs of Cœlenterates, the Cuvierian organs of Holothurians (which much resemble the secretion of *Polyodontes*), and the cuticular organs of worms other than Annelids. In the Arthropodan phylum the spinning glands of Annelids appear to have as homologues the spinning and crural glands of *Peripatus*, the spinning and coxal glands of Myriopods, the coxal glands of Thysanura, and the spinning (and ? coxal) glands of Insects, and the same glands in Arachnids. The nephridia of Annelids have as homologues the salivary glands and genital ducts, and in some cases perhaps also glands of offence. The cuticular structures of Molluscs and Vertebrates are next considered. The other systems of organs are dealt with in a similar, though not always so comprehensive a manner.

The third section of the monograph deals with physiological questions. Among those discussed are the pigments of the gastric region of the enteron in *Capitella*, which are shown to be free from bile-pigments and acids; the mode of ingestion of carmine and the absence of intracellular digestion; the respiratory action of the enteric appendage. The view that the neurochord is a supporting organ for the ventral cord is accepted. Some additions are made to the author's already published observations on the lateral and goblet-shaped organs. The chemical properties of the blood, and of the excretory vesicles and concretions found in the nephridia are discussed. The mode of excretion of carmine is described, and evidence is given of the excretory activity of systems of organs other than the nephridia. The significance of pigment from various points of view is fully considered.

The concluding chapter is systematic and faunistic, and concludes with some phylogenetic observations, the chief outcome of which is that Annelids should not be divided into Oligochæta and Polychæta, but that the former should merely be regarded as a family of Annelids.

The wide range of this work will be evident from this short notice, and its importance will doubtless be great.

Homology of Segmental Organs and Efferent Ducts of Genital Products in Oligochæta.*—Dr. O. Lehmann is of opinion that in the earthworm there are two germ-epithelia for the mother-cells of the spermatozoa, one the small bodies called testes by Hering, and the other the so-called sperm-reservoirs or testes of D'Ukedem. The mother-cells of the former continue their development in the median seminal reservoirs in such Lumbricidæ as are provided with them and in others, e. g. *Allolobophora*, freely in the cœlom. The efferent ducts of the male products are the vasa deferentia, each of which commences by a large, folded infundibulum. In the species which are provided with a median seminal capsule (or sperm-reservoir), the funnel is in-

* Jenaisch. Zeitschr. f. Naturwiss., xiv. (1887) pp. 322–60 (1 pl.).

closed by it. In *Allolobophora* the funnel consists of two elongated lips, which lie against one another and have ciliated epithelium on their inner surface. The canals from the funnels do not unite till they reach the fourteenth segment. The funnels may be regarded as thickenings of the peritoneum, and the vas deferens is at first a solid cord of cells, which in time becomes hollow. The oviducts are developed in the same way; the funnels are thickenings of the peritoneum at the side of the segmental funnel, and the receptacula are thickenings of the peritoneum of the dissepiment. In their mode of origin, then, the male seminal reservoirs and the receptacula ovorum present great similarity, and may be homologous, but in their functions they are quite different, so that the peculiarities of the receptacula must not be regarded as a proof of the non-testicular nature of the seminal vesicles.

Lehmann is of opinion that the vasa deferentia and oviducts have no genetic relations to the segmental organs. As, however, they have to perform the same kind of function—the removal of material from the interior of the body—it may well happen that vasa deferentia may serve as ducts for the excretory organs, and the excretory ducts carry away generative products to the exterior.

Structural Characters of Earthworms.*—Mr. F. E. Beddard describes a new genus of earthworms—*Neodrilus monocystis*—from a single specimen which it is possible may be really an *Acanthodrilus* in which the posterior pair of male generative pores, together with their glands, have not yet been developed. A detailed account is given of *Urochæta* sp. from Queensland, which is compared with *U. corethrurus*, and *U. dubia*. *Perichæta newcombei* sp. n. is remarkable for the great development of the genital papillæ; while agreeing in many points with the two species—*P. australis* and *P. coxii*—lately described by Mr. Fletcher, it differs in the presence of vesiculæ seminales in all of the segments from 9–12 inclusive. *P. upuloensis* sp. n. is, also, mainly characterized by the number and arrangement of the genital papillæ. It would seem that the number and arrangement of these papillæ afford good characters for discriminating the different species of *Perichæta*, although the number is apt to vary somewhat at different stages of maturity.

New Australian Earthworms.†—Mr. J. J. Fletcher gives descriptions of ten new species of Australian earthworms, but he leaves the consideration of morphological details for a future revision. All but two belong to the common Australian type *Perichæta*, and one—*P. canaliculata* — is interesting as being intra-clitellian, while another — *P. wilsoniana*—has most of its representatives post-clitellian, but one is intra-clitellian; these facts support the view of Mr. Beddard that Perrier's division of intra- and post-clitellian groups is too artificial to be permanently retained. A new genus, *Perissogaster*, is established for a form, *P. excavata*, which is characterized by the possession of three gizzards, while it differs from the West Indian genus *Trigaster* of Benham in the characters of its generative apparatus. One species is referred provisionally to *Cryptodrilus*, and is called *C. rubens*. The other new forms are *Eudrilus* (?) *dubius*, *Perichæta exigua*, and var. *murrayana*, *P. monticola*, *P. stirlingi*, *P. raymondiana*, *P. hamiltoni*, and

* Proc. Roy. Soc. Edinburgh, 1886–7, pp. 156–76 (1 pl.).
† Proc. Linn. Soc. N. S. Wales, ii. (1887) pp. 375–402.

P. fecunda. *Eudrilus dubius* has only been obtained from gardens, and it is not certain, therefore, that it is a true Australian form.

Mr. Fletcher also * gives a preliminary account of six new species of earthworms, four from Victoria, one from Tasmania, one from New South Wales. The Tasmanian form and one of the Victorian forms were very large, and presented favourable opportunities for the study of the reproductive organs, in regard to which fuller details are promised. In the Tasmanian *Notoscolex* the true testes were very well seen as two pairs of small cellular masses, each made up of an inner solid portion attached at one point to the mesentery, and of an outer portion consisting of numerous short radiating filaments. The new species are *Notoscolex gippslandicus* (apparently 4 to 6 feet long, said to be able to produce sounds), *Notoscolex tasmanianus* (peculiarly thick), *Notoscolex tuberculatus* (very slender), *Cryptodrilus mediterreus*, *Perichæta bakeri*, *Perichæta dorsalis*.

Nephridia of Earthworms.†—Mr. F. E. Beddard calls attention to the occurrence of numerous nephridia in the same segment in certain earthworms. In *Acanthodrilus multiporus* there are more than one pair of nephridiopores in each segment, but no internal orifices could be detected, and the appearances presented can only be explained on the assumption of a network of nephridial tubules. In *Perichæta* ‡ the nephridial network of one segment is continuous through the septum with that of the next, so that the system differs from that of any other "Annelid," except *Pontobdella*, in that it forms a continuous network uninterrupted by the intersegmental septa. There also appears to be a perfect continuity between the nephridial system of the right and left halves of the body, but there is no longitudinal duct on either side, as in *Lanice conchilega*. No traces of internal apertures could be seen. In *Typhæus* and *Dichogaster* numerous nephridiopores in a single segment have likewise been observed.

In proceeding to consider the relations of the excretory organs of Annelids to those of Platyhelminths, Mr. Beddard indicates the views of preceding writers. The facts here recorded support the view that the annelid excretory system is directly traceable to that of the Platyhelminth, but a rather different account of the course of development than that proposed by Lang is given. *Perichæta* appears to be the most archaic form; *Acanthodrilus multiporus* offers the next stage, and with it the Capitellidæ present many points of agreement. The gap between *Acanthodrilus* and *Lumbricus* is only very partially bridged over by *Plutellus*, where the irregularity in the position of the nephridiopores is, perhaps, to be regarded as a last trace of the numerous pores of *Acanthodrilus* and *Perichæta*. The recent researches on the epiblastic origin of the segmental duct of vertebrates and the longitudinal duct of *Lumbricus* must make us hesitate to accept Lang's view of the identity of the longitudinal duct of *Lumbricus* with the longitudinal canals of Platyhelminths, for the latter are of mesoblastic origin.

Anatomy of Allurus tetraedrus.§—Mr. F. E. Beddard finds that *Allurus* ‖ differs from *Lumbricus* in having the male reproductive folds on

* Proc. Linn. Soc. N. S. Wales, ii. (1887) pp. 601–20.
† Quart. Journ. Micr. Sci., xxviii. (1888) pp. 397–411 (2 pls.).
‡ See also Proc. Roy. Soc., xliii. (1888) pp. 309–10.
§ Quart. Journ. Micr. Sci., xxviii. (1888) pp. 365–71 (1 pl.).
‖ "*Allolobophora*," on p. 370, is evidently a misprint for "*Allurus*."

segment 13, and therefore in front of the female generative orifice. There appears to be but one pair of spermathecæ, which open on to the middle of their segment, a little to one side of a seta. The calciferous glands of consecutive segments are not distinct from each other; they occupy segments 10–14. The gizzard is confined to a single (the 17th) segment. There is a continuous glandular fold on either side of the body, which is of the same structure as the clitellum, extending from the 4th to the 24th segment, and interrupting the muscular layers. This glandular mass is specially developed in segment 13, round the orifice of the vas deferens.

Anatomy of Perichæta.*—Mr. F. E. Beddard has some preliminary notes on the anatomy of this earthworm. He finds that the salivary glands exhibit a metameric arrangement, and he looks upon them as the homologues of the septal glands of the Enchytræidæ and Lumbricidæ. There are a number of small glands which may possibly represent the capsulogenous gland of *Lumbricus*, but, in the absence of any definite knowledge of the histology of these glands in the earthworm, it is impossible to speak with certainty. In *P. mirabilis* and *P. aspergillum*, the organs consist of groups of unicellular glands. As their number and position differ in four known species, their arrangement may furnish a means of discriminating the species of the genus.

Mucous Gland of Urochæta.†—Mr. F. E. Beddard finds that the "mucous gland" of *Urochæta* is provided with cœlomic apertures, which have the form of large funnel-shaped ciliated discs, composed of the usual columnar cells. This character, added to those discovered and described by Prof. Perrier, completes the resemblance of these organs to nephridia. The "mucous glands" consist, in fact, of a tube opening on to the exterior by a single orifice, and branching distally into a number of tubules, each of which opens into the cœlom by a ciliated funnel. These funnels appear to be disposed irregularly and not metamerically.

β. Nemathelminthes.

Structure of Echinorhynchi.‡—Dr. R. Koehler has had great difficulty in obtaining specimens of *Echinorhynchus gigas* from the Pig, which seems to be becoming excessively rare. He was specially interested in the structure of its muscular system.

He finds that in *Echinorhynchi* the elements of the muscular system become differentiated into cells; these are sometimes numerous, and the contractile substance forms a single group of fibrils in each cell (transverse fibres of *E. hericca*); sometimes the fibrils form two or three distinct groups in each cell, but the size of the latter does not notably increase, nor does the protoplasm become less abundant (longitudinal fibres of *E. hericca*). In other forms (*E. angustatus* and *E. proteus*) the groups of fibrils become more numerous in each of the muscular cells, and these are larger in size, and the remains of the protoplasm are more reduced. Finally, in *E. gigas*, the muscular cells are of enormous size; a very large number of fibrils appear in their protoplasm, and take on a much more complicated structure than in other types; they become much more perfectly isolated, and are better differentiated from the formative protoplasm in which they are placed.

* Zool. Anzeig., xi. (1888) pp. 91–4.
† Ibid., pp. 90–1.
‡ Journ. Anat. et Physiol. (Robin), xxiii. (1887) pp. 612–59 (2 pls.).

With regard to the affinities of the Echinorhynchi, reference should be made to the remarkable form *Paradoxites* discovered by Lindemann; in it the body is flattened, and divided into distinct rings, of which all but the first and last three are similar in character. The proboscis and its receptacle in the first ring are like those of other Echinorhynchi; there is a pair of ovaries in every ring, and they open into two longitudinal lateral canals; the male organ is found in the same individual, and consists of a long tube which arises from the floor of the receptacle, and has a swelling in each ring. The oviducts and the efferent canals open to the exterior by a single duct. *E. roseus* differs only from *Paradoxites* by the absence of rings. Notwithstanding the incompleteness of our knowledge of this form we cannot doubt its affinities to the Cestoda. If it should be proved that *Paradoxites* is not an ancient form, then the origin of the Echinorhynchi must be sought for in oligomeric worms, such as the Gephyrea, and the lemnisci may be regarded as segmental organs. But the pressing point is, obviously, further study of *Paradoxites*.

Fertilization and Segmentation in Ascaris megalocephala.*—Prof. E. van Beneden publishes a preliminary account of his further researches on the ova of *Ascaris megalocephala*. These have been made in association with M. Ad. Neyt, well known for his applications of photography to microscopical and astronomical purposes. He has succeeded in obtaining a series of about 1200 photographs of all the details of maturation, fertilization, and karyokinesis. Prof. van Beneden has for two years been making use of a more rapid and satisfactory method of fixing and hardening his objects.†

From the first, two nuclear elements can be seen in the ova. The moment when the male pronucleus is formed at the expense of the small chromatic nucleus of the sperm coincides exactly with that at which the female pronucleus is formed from the two chromatic rod-like elements which result from the second pseudo-karyokinetic figure. At the moment of origin the male pronucleus is enveloped in the degenerate residue of its protoplasmic body which does not lose itself in the egg-protoplasm, but forms a definite layer round the male pronucleus, becoming gradually reduced to a globule, and finally being digested away. With the staining reagents above noticed the protoplasmic body becomes brown, the chromatic elements green, the vitellus almost colourless. Before the male pronucleus has freed itself from its degenerating mantle, the female pronucleus is formed as a reticulate nucleus near the second polar body. The chromatin, at first homogeneous, resolves itself into a network of granules united by filaments; from the periphery of the two rods issue small tracts of achromatic granules united in filaments; the rods increase rapidly in volume, and invade the surrounding clear space. A discussion of the value of his method, and of the possibilities of error, is also given. He then proceeds to describe his results at length.

I. *Formation of Pronuclei.*—The origin of one of these from the nucleus of the sperm, of the other from the residue of the germinal vesicle, is described as in the first classic research, which in this particular is left unaltered.

* Bull. Acad. R. Sci. Belg., xiv. (1887) pp. 215-94 (6 pls.).
† Cf. *infra*, Microscopy β.

II. *Preliminary Kinesis.*—The pronuclei do not conjugate. The formation in each of a chromatic band (cordon) is intimately described. It resolves itself into two primary chromatic loops. The pronuclei are directed laterally to one another, with their polar regions towards the attractive spheres between them. At length the chromatic loops of the two groups come to lie indistinguishably side by side. They then form secondary loops by longitudinal division. The primary chromatic stars divide into two secondary chromatic stars, which separate. The order of priority as regards the longitudinal division of the primary loops is (1) Van Beneden; (2) a month later, Hensen; (3) several months later, Rabl. There is no fusion of pronuclei; the chromatin elements of male and female pronucleus furnish each two chromatic loops to the nuclei of the two first blastomeres; the same process always occurs; transmission is effected, therefore, by the chromatic distribution.

III. *Theory of Fertilization.*—It is evident that the facts of fertilization, according to Van Beneden, are not exactly harmonious with Hertwig's theory of fertilization. The nuclear fusion so important for the latter is not recognized by the former. (1) The genesis of the pronuclei coincides exactly with the elimination of the second polar globule, i. e. with the completed maturation of the ovum. (2) In the vast majority of cases the pronuclei do not even become adjacent. (3) The preliminaries to the dicentric figures take place simultaneously in the two pronuclei, which, though distant, behave exactly as if they were one. (4) Two nuclear elements, the equivalent of two chromatic loops, are eliminated by the ovum in the formation of polar globules, in such a way that the female pronucleus differs from that of the ordinary cells in including only two instead of four chromatic loops. (5) The male nucleus also includes only two chromatic elements, instead of the four found in the spermatomeres; like the female pronucleus, it is a seminucleus. (6) From the moment when the pronuclei become spherical reticulate nuclear bodies, kinesis begins. The first embryonic cell capable of division, and potentially representing the future individual, is formed at the moment when, at the expense of the remnant of the egg-chromatin on the one hand, and of the spermatozoid-chromatin on the other, two nuclear reticulated elements are formed. Together these represent a complete nucleus. It is quite indifferent whether they approach and fuse; in *Ascaris*, in fact, this does not take place in the immense majority of instances. Then there follows a vigorous criticism of Carnoy and Zacharias. His answer to the former does not lack in asperity.

IV. *Metaphasis and Anaphasis.*—(1) The doubling of the primary chromatic loops frequently exhibits this peculiarity, that in the blastomeres the secondary loops may remain united by their extremities, though otherwise distant. As the result of this terminal union a barrel-shaped figure is produced. This may be called the heterotypical form, and is minutely described. (2) In this form the incurved extremities of the secondary loops are never directed directly towards the poles of the dicentric figure, as Flemming represents in the spermatogenesis of *Salamandra*. The constitutive fibrils of the achromatic spindle are clearly contractile. In a large number of cases the primary and secondary chromatic loops are found to be connected by interposed achromatic fibrils, which are probably contractile, and explain the relative displacement of the primary loops preliminary to the formation of the equatorial star. (3) As to the reconstitution of the nuclei derived from the dyasters, what

Flemming has described does not take place in *Ascaris;* but this subject is too complicated to admit of brief summary.

V. *Origin of attractive spheres, asters, and achromatic spindle.*—The "attractive spheres" are to be observed in the ovum, not only during the stages of "pelotonnement," but even earlier, when the pronuclei are still reticulate and far separate from one another. The two appear simultaneously. They are slightly separate, and sometimes, if not always, the fibrils have their central corpuscles united. Their position in relation to the pronucleus seems to vary considerably in different ova. The various positions and the relation to division are described. The first plane of division does not represent in the *Ascaris* ovum the median plane of the animal. The attractive spheres become more conspicuous and extensive the further advanced the development of the pronuclei. It is absolutely certain that the achromatic spindle is in part derived from the attractive spheres. When the contours of the pronucleus are still present, those rays of the spheres which are directed towards the pronucleus become more apparent than all the other rays of the asters. Often they converge, not towards the centres of the attractive spheres, but towards a globule situated between the medullary and cortical zones of the spheres. There appear to be two stellar centres, one for the spindle, the other for the aster.

The further history of the attractive spheres is followed in detail. The doubling resulting from the division of the central corpuscles and of the attractive spheres is intimately described. The spheres are permanent organs of the cell, presiding over division. All the internal movements which accompany cellular division have their immediate condition in the contractility of the fibrils of the cellular protoplasm, which form a kind of radial muscular system, composed of antagonistic groups. The central corpuscle has the role of an organ of insertion. It is the first to divide, and its doubling leads to the grouping of the contractile elements in two systems.

VI. *The form and structure of the cell during mitosis* is the subject discussed in the last chapter of the memoir. (1) Subequatorial circles mark on the surface of the cell the boundaries of the regions invaded by the radiations of the asters. In metakinesis the cells have three portions: (*a*) two asteroid, rounded, radiate regions, round the central corpuscles of the attractive spheres, and separated medianly by the chromatic equatorial plate; and (*b*) a marginal ring, determining the superficial formation which van Beneden calls the "bourrelet équatorial." (2) The circles and polar elevations depend upon the presence of antipodal cones, that is to say, on fibrillar cones where the radiations of the asters are more voluminous and more active. The polar elevations are probably dependent on the contractions of the fibrils of the antipodal cones. The author calls attention to a recent research by Boveri, which confirms some of his results. Explanation of six plates is given, but only two are appended. Those are very clear, and in part semidiagrammatic.

Polar Globules of Ascaris.*—Herr T. Boveri has made some important contributions to the investigation of the processes of maturation in the ovum of *Ascaris.* Van Beneden's prophecy has been indeed fulfilled, for the eggs of these Nematodes have become zoologically

* Biol. Centralbl., viii. (1888) pp. 17–9. Zellen-Studien, Jena, 1887, 4 pls.

"classic." The species which Boveri studied were *Ascaris megalocephala* and *A. lumbricoides*.

(1) The author has shown, and the observation is very welcome, that two types of ovum exist, one (van Beneden's type) with a single chromatic element, the other (Carnoy's type) with two.

(2) He is also convinced that the separation of the two polar globules in both the species investigated is a true mitotic division, and no pseudo-karyokinesis as van Beneden would have it.

(3) His main conclusions are as follows:—(*a*) the daughter elements shift to the poles of the directive figure, and true daughter plates arise; (*b*) the spindle is lessened before division, but does not disappear; (*c*) the chromatic elements are halved in the formation of each polar globule; (*d*) in each of the two polar globules there are exactly as many elements as are present in the ovum at the moment of the formation; (*e*) of each of the elements half goes to the first polar globule, and the elements are again halved to form the second body; the female nucleus contains as many elements as the germinal vesicle, though each is reduced to a quarter of its original volume; (*f*) the fibres between the daughter plates are not independent of the old figure, but are indeed the same as the "connecting fibres" of the karyokinesis.

Life-history of Ascaris lumbricoides and Tænia elliptica.*—Dr. A. Lutz brings forward some evidence in favour of the view of Grassi that these parasites may continue to exist without the intermediation of a second host. Prof. Leuckart † fully recognizes the lacunar condition of our helminthological knowledge, but does not think that there is yet sufficient evidence to justify us in regarding as incorrect conclusions which are founded on positive facts.

γ. Platyhelminthes.

Development of Generative Organs of Cestoda.‡—Herr F. Schmidt comes to the conclusion that the whole of the generative apparatus of Tapeworms, inclusive of the efferent ducts and genital passages, arises from elements of the parenchyma; or, in other words, from elements of the parenchyma of the young proglottids which is characterized as tissue of an embryonic character. The organs are not developed from one rudiment, nor are they to be referred to a definite group of cells; they appear as quite independent rudiments in the parenchyma and in positions which correspond generally to the position of the fully developed organs. The yolk-glands of *Bothriocephalus* and *Triænophorus* arise quite independently of the primary generative rudiment, for their elements are at first scattered in the parenchyma of the cortical layer at a time when the primary generative rudiments have not undergone much differentiation, and before the efferent ducts have been developed. In a good series of sections it is easy to show that the testicular vesicles are likewise independently developed in the parenchyma of the median layer. These observations doubtless apply to other Cestodes. The so-called primary generative rudiment is not a sharply limited structure, which can be easily distinguished from the surrounding parenchyma; it does not become distinct when the different organs begin to be differentiated; it grows by the constant proliferation of

* Centralbl. f. Bakteriol. u. Parasitenk., i. (1887) pp. 713–8.
† Loc. cit., pp. 718–22. ‡ Zeitschr. f. Wiss. Zool., xlvi. (1888) pp. 151–87 (2 pls.).

the elements of the surrounding parenchyma which become fused with it. In consequence of this it is difficult to determine whether the several elements which become converted into the elements of the ovary arise from the primary rudiment, or from the parenchyma.

Put shortly, we may say that the development of the generative organs commences with the differentiation of the efferent apparatus; the germ-producing organs appear later, and, in correspondence with their position in the mature proglottis, either more or less closely connected with the rudiment of the efferent apparatus, or quite independently of it. The information which we have as to the mode of development of the generative organs of other Platyhelminthes is too slight and too contradictory to enable the author to make any useful comparisons between them and the Cestoda.

Interesting Specimen of Tænia saginata.* — Dr. J. G. Stanton gives an account of a specimen of *Tænia saginata*, which is remarkable for its unusual length and for the malformations it presents. The total is estimated as 1061 joints in a chain about 7·655 metres long; with this remarkable length the number of joints is rather below than above the average. There is an extra joint which is heart-shaped, and has its inner border resting in a semicircular depression at one side of the chain, opposite the point of union of two adjoining segments of large size. Its free border extends some distance beyond the lateral margins of the two adjacent joints, and terminates in a slightly rounded point. The largest number of successive joints with genital foramina on the same side is six.

Generative Apparatus of Diplozoon paradoxum.† — Dr. E. Zeller has investigated the structure of the generative apparatus of *Diplozoon paradoxum*. The male apparatus consists of a single testis with one duct, while the female organs are the ovary with its duct, the yolk-gland with its duct, the canal of Laurer, the uterus and oviduct, and an external papilla.

The testis is placed in the hindermost part of the hind-body, is of considerable size, and has a rounded slightly lobate form. There is a fairly well-developed investing membrane within which are very clear cells with a diameter of 0·015 mm., and of an irregularly polyhedral form. The nucleus is of an extraordinarily large size, its membrane is very thick, and the homogeneous fluid contains distinct nucleoli. The spermatozoa are long.

The ovary occupies the anterior half of the hind-body; it is elongated, and curved in such a way that its commencement and termination lie close to one another, as van Beneden has already observed. The youngest are very small and indistinct; as they pass forwards they increase in size and finally become quite large. The ovule, when ready to leave the ovary, has a thick and very elastic envelope, a finely granular yolk, a germinal vesicle filled with clear fluid, and a germinal spot in which there is one large or several smaller cavities. Its duct is proportionately narrow, but very extensile. The yolk-gland is a large organ, and its rounded lobules fill up the greater part of the fore-body; its constituent cells are more or less rounded. The number of lobules is so extraordinarily large, and are so closely packed, that it was not

* Zool. Anzeig., xi. (1888) pp. 94–5.

† Zeitschr. f. Wiss. Zool., lvi. (1888) pp. 233–9 (1 pl.).

possible to find an efferent duct in the mass of the gland; where it emerges from the gland it is simple. The uterus is a cavity of considerable size, and, when empty, lies on the outer side of the yolk-sac; on its inner free surface there are a large number of clear hemispherical cells, which are very thick-walled; at its upper end is the narrow but extraordinarily extensile oviduct.

From this description it will be seen that the generative apparatus of *Diplozoon* agrees essentially with the arrangements seen in other Trematoda; it is peculiar for the passage of the canal of Laurer through the yolk-duct, and the fact that this canal does not open on the dorsal surface of the body. In consequence of the cross-like fusion which the ventral surface of one animal makes with the dorsal surface of the other, the end of the seminal duct of one, and the commencement of the canal of Laurer in the other pass directly into one another. The mutual relation which is permanent in *Diplozoon*, is probably temporarily effected between other mutually impregnating Trematoda.

Second Species of Turbellarian Living on Nebaliæ.*—Mr. W. Repiachoff, who some years ago† described a species of Turbellarian living on *Nebaliæ* at Trieste, has since found another species at Marseilles. He points out the differences between the two forms; of these, the most important is the slighter development of the creeping sole. It will be remembered that a sole is found in the genus *Acmostoma*, from which Graff is inclined to derive the Platycœhlides. The new type, to which no name is given, does not belong to the same family or even group (Alloiocœla) as that genus; and it must therefore be conceded that a creeping sole may be independently developed in quite different groups of the Rhabdocœlida.

In the possession of ventral setæ, the new type calls to mind certain Rotifers, *Dinophilus*, and some Annelids, but as it cannot be supposed that it is their ancestor, we must suppose that the disappearance or reduction of dorsal setæ may also occur independently in various worms.

These results appear to the author to justify the view that among the lower Bilateria there may appear sporadically characters which in the more highly organized groups become distinctive characteristics, and may there be justly regarded as proofs of community of descent. On the other hand, we know that it has not yet been possible to find complete series of intermediate forms between the Turbellaria and the higher Bilateria, and it is possible that they were derived from Turbellaria, which were as different from the Acœla, Alloiocœla, Rhabdocœla, Polyclades, and Triclades, as there are groups one from another. It may, in fact, be some day shown that the Turbellaria form a small side branch of the trunk of the Metazoa. The author thinks that in our phylogenetic speculations, we must be content with the fact that the Bilateria are probably derived from Cœlenterata, or Cœlenterate-like organisms (*Gastræa*).

New Remarkable Worms.‡—M. J. Kunstler has found in the intestine of *Solen vagina* a Cestode and a Planarian, and in the tissues of the body an *Echinobothrium*. The first of these is microscopic in size, pyriform in shape, and without any indications of segmentation. At its anterior extremity there is an enormous imperforate sucker; in the

* Zool. Anzeig., xi. (1888) pp. 141–4.
† See this Journal, 1885, p. 248.
‡ Comptes Rendus, cvi. (1888) pp. 553–4.

median region of the body there are four other suckers, which are often of a bright red colour. The excretory pore at the hinder end of the body is the orifice of a single duct, which is not swollen into a vesicle, and which soon divides into two. The two branches extend to the base of the anterior sucker, where they bend backwards to pass into the general parenchyma of the body, where they terminate in small swollen ends, which are, in all probability, vibratile infundibula. There are calcareous grains in the parenchyma of the body. As the forms examined were devoid of generative organs, it is probable that they are immature, and that they are destined for some large fish or a Cetacean. The Cestode parasites of *Sepiola atlantica* and *Pleurobrachia pileus* are distinguished from that here described by the absence of the enormous anterior sucker. The Planaria of the Solen is never more than two millimetres in length; the body is clothed in cilia which take on special characters near the anterior end. Two large black eyes, provided with a very large crystalline lens, are situated at about the level of the mouth, and receive large nerves from the cerebral ganglia. The mouth is surrounded by a rosette, and followed by a distinct, simple, and elongated digestive tube. Beneath the peripheral cellular layer which carries the cilia, there is a dense, pale yellow parenchymatous layer, while the rest of the body is filled by a colourless vesicular parenchyma; in this last tissue ova are found in all stages of development, and the young are not expelled until they are completely developed. Vesicles filled with spermatozoa are found in the same parenchyma. On either side of the body there are elongated tracts, which appear to be accessory glands of the reproductive apparatus.

Echinodermata.

Longitudinal Muscles and Stewart's Organ in Echinothurids.*— Herren P. and F. Sarasin have made some anatomical investigations on the Echinothurid which they called *Cyanosoma urens*, but which they now recognize to belong to the genus *Asthenosoma*. The five pairs of longitudinal muscles which extend between the boundaries of the ambulacra and interambulacra are not simple smooth bands, but are made up of a number of radially arranged muscular bundles. The separate bundles arise from the outermost ends of the ambulacral plates, and extend centrally into a small tendon. The tendons fuse with one another, and so form a true centrum tendineum about the middle of each muscle. A complete muscle, seen from the side, is semilunar in form; its lowermost bundles are inserted into the auricles; from the adoral auricular surfaces there arise still wider, but much weaker bundles, which are inserted serially into the buccal membrane. These semilunar longitudinal muscles divide the body-cavity into ten chamberlets, of which the five interambulacral are broader than the five ambulacral. Sir W. Thomson saw these muscles, but described them as mere fasciæ; they not only serve as locomotor organs, but also as suspendors of the enteron. Such muscles are wanting in Echinids with firm tests, but in the Diadematidæ and allied forms the relations of the enteric mesentery recall the arrangement of muscles in the Echinothuridæ. The organs of Stewart were first seen in the Cidaridæ; in *Asthenosoma* they are also well developed; they are five thin-walled vesicles, about five centimetres

* Zool. Anzeig., xi. (1888) pp. 115–7.

long, lying in the free ambulacral chamberlets. In *Asthenosoma* they are mere evaginations of the membrane of the lantern, and are devoid of the secondary diverticula which they have in the Cidaridæ.

Researches on Dorocidaris papillata and other Mediterranean Echinids.*—M. H. Prouho has, *inter alia*, studied the development of the spines of *Dorocidaris papillata*. He has not been able to determine the functions of the glandular pedicellariæ, each calcareous valve of which contains a mucous sac. The principal bundles of the peripheral nerve-plexus are situated in the special grooves hollowed out in the calcareous surface of the test; this discovery explains the nature of the grooves which have been observed on fossil species; the peripheral plexus forms a nerve-ring at the base of each spine, which is visible to the naked eye. The ambulacral nerves are tubular, and the intra-neural space ends between the epithelium of the pharynx and that of the peristomial lip. The internal part of the ambulacral nerve-tubes forms the peribuccal ring, which is continuous with the epithelial layer of the pharynx. In *D. papillata* alone, so far as is known, there is no intestinal siphon to the digestive tube. The visceral lacunar system is solely composed of lacunæ hollowed out in the connective tissue of the mesenteric layers; the absorbing capillary plexus opens into two marginal lacunæ, one of which is external and one internal. The internal marginal lacuna leads into a peri-œsophageal ring which is placed in the internal wall of the aquiferous ring. This lacunar ring gives rise to a plexus which is distributed to the ovoid gland, and is continued into the genital pentagon, and five pharyngeal lacunæ; the latter give off five radial lacunæ, which again give off lateral branches for the tentacles. No Polian vesicles are differentiated from the œsophageal rings. The visceral lacunar system does not communicate with the exterior; nor does the ring belonging to that system communicate with the aquiferous ring.

The larval form of *D. papillata* is a pluteus with four pairs of arms, two of which have delicate spicular networks; the cupola is flattened, and has two lateral lobes, in addition to which there are other well-developed lobes along the ciliated fringe; there are no ciliated epaulets.

In *Echinus acutus* M. Prouho has discovered the peripheral nerve-plexus, and a genital nerve-ring connected with the five ambulacral nerves. In *Strongylocentrotus lividus* the five genital glands were observed to arise from a single primitive bud, which is developed at the expense of the mesentery; the ovoid gland is not a genital stolon. *Spatangus purpureus* has an internal apophysis, at the extremity of which the aquiferous tube and the annexed canal open. The internal marginal lacuna gives off a branch which forms a circumoral lacunar ring; this ring gives off on one side five radial lacunæ, and on the other a lacuna (glandular canal) which extends as far as the ovoid gland, is distributed in its walls, and ends in a plexus in the membrane which connects together the four genital glands. The aquiferous apparatus is divided into two parts which do not communicate with one another; there is the true aquiferous tube, prolonged by a ramified canal which ends in a cul-de-sac near the œsophageal region, and an ambulacral system consisting of five radial vessels, a circumoral ring, and a canal which extends along

* Arch. Zool. Expér. et Gén., v. (1887) pp. 213–380 (13 pls.). See also this Journal, 1887, p. 406.

the œsophagus, and ends in a cul-de-sac. The visceral lacunar system communicates with neither of these parts, nor with the exterior.

Echinoidea of Japan.*—The first part of Dr. L. Döderlein's monograph of the Echinoidea of Japan deals with the Cidaridæ and Salenidæ; four new species of *Cidaris*, a new *Porocidaris*, and three species of *Goniocidaris* are described; of the latter *G. mikado* is remarkable for the small number of coronal plates, and the extraordinary form of the spines.

Gemmation in Linckia multipora.†—Drs. P. and F. Sarasin have published a further account of their observations on gemmation in *Linckia multipora*,‡ where they add to their own facts an historical notice of what has been seen and said by some other observers, and give illustrations of the specimens they collected.

Emigration of Amœboid Corpuscles in the Star-fish.§—Mr. H. E. Durham has made some observations on the emigration of amœboid corpuscles in *Asterias rubens*. Indian ink or precipitated anilin blue was injected into the cœlomic cavity; the granules thus introduced are ingested by the amœboid corpuscles that float in the cœlomic fluid, and the granule-laden phagocytes can be seen very plainly in the dermal branchiæ of a living specimen; here the cilia of the cœlomic epithelium cause them to dance up and down in the branchia, and to be thrown against the wall; every now and then a corpuscle adheres at or near the apex of the branchia, and by repetition a small clump may be formed. After adhesion the corpuscles creep by their amœboid movement through the cœlomic epithelium, the connective tissue layer, and the epidermis to the exterior, and the animal is thus freed from some of the irritating particles. For a time the corpuscles retain their irregular amœboid shape; they then become spherical and swell up; later they disintegrate, and the contained granules are set free.

Besides the corpuscles containing Indian ink, others were found loaded with refringent granules. If a star-fish be kept in a vessel into which fresh sea-water is constantly dripping, it throws off from its surface a certain amount of a dirty brownish slime. This slime appears to contain identically loaded corpuscles. For such bodies the author proposes the term sphæruliferous. On them a holotrichous Infusorian and a species of *Caprella* were seen to feed.

Madreporite of Cribrella ocellata.‖—Mr. H. E. Durham has made a series of vertical longitudinal sections through the madreporite of a full-grown specimen of *Cribrella ocellata*, in which the madreporic canals have a peculiar relation to the stone-canal or water-tube. Most of the pore-canals pass into collecting canals, which open into the stone-canal directly; but a few lead into the space below the madreporite, which is the upper extremity of the "schlauchförmiger Kanal." The stone-canal dilates laterally on either side into an ampulla, and one of these has an aperture into the latter canal. Now this is derived from the enterocœle, so that, in the specimen described, there is a permanent connection between the hydrocœle-cavity and the enterocœle-cavity. It is not yet known whether or no this is an abnormal arrangement.

* Nature, xxxvii. (1888) pp. 243–4.

† 'Ergebnisse Naturw. Forschungen auf Ceylon' (Wiesbaden, 1888), pp. 74–9 (1 pl.).

‡ See this Journal, *ante*, p. 233.

§ Proc. Roy. Soc., xliii. (1888) pp. 327–30 (1 pl.).

‖ Tom. cit., pp. 330–3.

Morphology of Ophiurids.*—Dr. O. Hamann has published a preliminary account of his observations on the morphology of Ophiurids.

(1) *Central or Peripheral Nervous System.*—This differs from that of Asterids by lying in the mesoderm. When sections are made of a nerve-trunk it is seen that its cellular investment is not always the same, the cells being sometimes in one and sometimes in several layers. There is only one layer at the points where the branchlets are given off to the pedicels. The cells are very small, the cell-substance can scarcely be seen, and there is a spherical nucleus. In the intermediate regions the cells are arranged in several layers, but no supporting fibres can be made out, and there is nothing which prevents our regarding them as ganglion-cells. This would show that the Ophiurids are the most highly developed of Echinoderms, for a segmentation of their nerve-trunks can be made out. Another peculiarity is the presence of a nearly circular blood-lacuna in the middle line of the nerve-trunks ; this passes towards the centre, where it meets with a circular blood-lacuna ring, which lies internally to the nerve-ring. Of the branches given off from the central trunks the author recognizes nervi costales, which pass to the intercostal muscles, and nervi epitheliales which branch in all directions. Below the epidermis there is a nervous plexus which may be distinctly seen on both arms and disc. In no group of Echinoderms is there such an exquisitely developed nervous system. The large number of epithelial nerves, and the extension of the sub-epithelial nerve-plexus, are closely associated with the great power of rapid movement possessed by these animals.

(2) *The Wandering Germ-cells and their Sites of Maturation.*—The ova and spermatozoa arise from primordial germ-cells, which make their way into the developing genital saccules, and then become differentiated. The author has discovered a genital tube, which extends partly into the dorsal wall of the disc and partly into the walls of the genital pouches. This tube is placed on a cord of connective substance and is surrounded by blood-fluid, which flows into the lacunæ and clefts of the cord. The latter lies in a schizocœl space. In structure this genital tube closely resembles that of Crinoids.

(3) *The Dorsal Pore.*—The author thinks that an association of Ophiurids with Asterids in one group can only be justified on the ground of their external similarity; otherwise the Ophiurids are more closely allied to the Crinoids. In an adult *Ophiolepis albida*, Dr. Hamann has discovered an excentrically placed dorsal pore. The body-wall is traversed by an infundibulum which puts the cœlom into communication with the sea-water. The inner wall is quite flat, and is lined by ciliated cells, which on the one hand pass into the outer body-epithelium, and on the other into the epithelium of the enterocœl. This pore has nothing to do with the stone-canal, but is to be compared rather to the calycinal pores of Crinoids.

(4) *Schizocœl Pores and Blood-lacunar System.*—In *O. albida* the author finds a space which passes partly into the dorsal wall of the body-disc and partly into the walls of the genital pouches. In this there lies the blood-lacuna ring, which takes the same course and lies in a septum of connective tissue. The blood-fluid flows into the peripheral lacunæ of this septum. These lacunæ are best developed in the dorsal

* Nachr. K. Gesell. Wiss. Göttingen, 1887, pp. 394–400.

wall, and thence a branch goes into the cœlom, extends to the enteron, where its wall fuses with that of the gut. There are also schizocœl spaces in the arms, which fuse around the pharynx into an oral schizocœl-sinus; in these the central nervous system is suspended. On this latter there is a blood-vessel, placed in a poorly developed connective-tissue-septum. These radial blood-lacunæ also form a circumoral ring, whence there is a communication of blood to the so-called heart.

Cœlenterata.

New Method of Multiplication in Hydroids.*—Prof. W. K. Brooks has observed a new method of multiplication in a species of *Oceania* found at the Bahamas. The hydroid larva is a small Campanularian, and the hydranths are carried in toothed cups; the blastostyles spring from the root, inclosed in nearly sessile gonothecæ, and produce a series of medusa-buds, which mature and escape in succession from the distal end. Soon after it is set free the medusa has a shallow bell, four radial and four interradial tentacles, capable of considerable extension, an otocyst on either side of the base of every interradial tentacle, and four rudimentary reproductive organs. A few of these medusæ presented a remarkable and unexampled peculiarity, for they had true blastostyles growing out from their reproductive organs into the cavity of the bell; these were inclosed in chitinous gonothecæ, covered with medusa-buds exactly like those on the blastostyles of the hydroid communities, and the little medusa which escaped from them was identical with those which were reared from the hydroid blastostyles. As the homology between blastostyles and hydranths is undoubted, and as nobody has questioned Prof. Brooks's dictum that the hydra is essentially a medusa-larva, we have in this *Oceania* an adult which buds off larvæ.

Sections show that the relation between the medusa and the blastostyle is quite anomalous and very different from that which ordinarily obtains between the bud and the parent in the Hydromedusæ. All the medusæ with blastostyles which were examined were found to be males, with a well-defined layer of ectoderm outside the unspecialized germ-cells of the reproductive organ, and this layer is directly continuous with the ectoderm of the blastostyles, but there is no connection between the radiating canal of the medusa and the stomach of the blastostyle, nor is the endoderm of the latter an outgrowth from that of the medusa. The endoderm of each blastostyle is quite independent of the same layer in other blastostyles upon the same reproductive organ.

Near the proximal end of each blastostyle the ectoderm becomes thickened to form a glandular collar, by which the perisarc of the gonotheca is excreted. The layer of ectoderm bends round the base of the sheath of perisarc, folding it into a circular furrow, outside which the ectoderm and its supporting layer is directly continuous with that of the medusa. The endoderm is continued into the substance of the reproductive organ as a hollow tube, which divides up into smaller tubes; these ultimately split along one side and flatten out into a single layer of cells directly continuous with the unspecialized germ-cells of the reproductive organs. In the body of the blastostyle the endoderm cells are opaque, granular, vacuolated, and filled with food-particles,

* Johns-Hopkins Univ. Circulars, vii. (1888) pp. 29–30.

but towards the base they become more transparent and similar, and in the branching tubes they become indistinguishable from those of the reproductive organs.

In early stages of the growth of new buds the endoderm is seen to be derived from the cells of the reproductive organs, and, when the buds are formed, the blastostyles are nourished at the expense of the tissue of the reproductive organs of the medusa.

We seem here to have to do with a peculiarly modified process of gemmation, and not with pædogenetic phenomena, as is probably the case with the "sporogenesis" observed by Metschnikoff in *Cunina*.

Anatomy of Madreporaria.*—Dr. G. H. Fowler gives an account of the structure of *Madracis asperula*, *Amphihelia ramea*, *Stephanophyllia formosissima*, *Sphenotrochus rubescens*, *Stephanaria planipora*, *Pocillopora nobilis*, and *Seriatopora tenuicornis*. He thinks there is evidence that the law that the body-wall, when present, is supported in acœnenchymatous forms upon peripheral lamellæ of the mesenteries, and in cœnenchymatous species upon the echinulations of the cœnenchyme, requires modification. The two methods of support may coexist in a cœnenchymatous form (*Madracis*), and to a certain extent in an acœnenchymatous (*Amphihelia*); the body-wall of acœnenchymatous species may rest, either mainly (*Amphihelia*), or entirely (*Stephanophyllia*) on pseudocostæ; in *Sphenotrochus* it rests on pseudocostæ and true costæ. These apparent exceptions to the law may be due to exceptional conditions, of which we are at present ignorant.

The ultimate attachment of the polyp to the corallum consists, in many genera, of a series of laminated offsets of mesoglœa in the neighbourhood of the mesentery; these are the structures which have been previously described as calicoblastic in function. In *Sphenotrochus* a sphincter muscle, comparable to the "Rötteken's muscle" of the Hexactiniæ, may be found in the region of the mouth-disc. In the same form follicle-cells, which are perhaps immigrants from the endoderm, may surround the ripening ovum as it lies in its mesoglœal capsule. *Stephanaria* appears to be distinctly degenerate, owing to the low development of the mesenterial filament, and the slight definition of the boundaries of the polyps which compose the colony; the individuality of the several polyps is, indeed, hardly more marked than in a Poriferan colony.

Development of Mancinia areolata.†—Mr. H. V. Wilson gives an abstract of his observations on *Mancinia areolata*, a common Astræid coral in the Bahamas, and allied to the well-known brain-coral. After segmentation there is a blastosphere with a very large cavity, and the cells contain numerous vacuoles which are probably filled with a fluid yolk; the germinal layers are formed by delamination, which takes place irregularly over the whole surface of the blastosphere. The permanent endoderm is a single layer of cells except in the region of the œsophagus, where it forms a solid mass which stretches from the œsophagus to the external ectoderm. The "mesenterial filaments" are found to be not the thickened edges of the mesenteries, but lobes of the œsophageal ectoderm. To form the first mesentery the whole œsophagus moves laterally towards the meridian of the future mesentery, until in

* Quart. Journ. Micr. Sci., xxviii. (1888) pp. 413–28 (2 pls.).
† Johns-Hopkins Univ. Circulars, vii. (1888) pp. 31–3.

this meridian there is nothing between the external ectoderm and the œsophageal ectoderm but the supporting lamella; the result of the movement is that the endoderm in the place of the first mesentery is pulled down; the œsophagus now grows downwards in the meridian as a lobe of ectoderm, which represents the first filament. The filament, like the œsophagus above it, rests on the supporting lamella, and is consequently flush with the surrounding endoderm. The second filament is formed on the opposite side of the animal in the same way as the first. After this the formation of mesenteries as such begins; the œsophagus withdraws from the body ectoderm along the line of the first, and subsequently of the second mesentery, remaining connected with it by the supporting lamella, which narrows to a thin band. The two intermediate chambers thus formed are at first solid. Below the œsophagus the endoderm forces its way under the short filaments, forming very slight ridges, with an axial band of supporting lamella; these ridges are the mesenteries, and on them the ectodermic lobes, or filaments, rest. When the two intermesenteric chambers are hollowed out the formation of the second pair of mesenteries with their filaments begins. The incomplete mesenteries of the larva are successively supplied with filaments by the reflection and upward growth of the ectoderm, and it is very probable that the incomplete mesenteries of the adult are so supplied in the adult.

In the older larvæ studied by the author the filaments are quite simple, and the cells are continuous with the endoderm of a thin mesentery. In the adult the edge of the mesentery is considerably enlarged, and forms two rather definite tracts, between which the filament proper rests. The author thinks that the very elaborate division of the filaments into three tracts physiologically distinct, made by the Hertwigs, cannot be considered as typical.

Mr. Wilson agrees with Koch, Fowler, and Bourne, in regarding the skeleton as a pure ectodermic structure, which is morphologically outside the body. With reference to the recent observations of Götte on the embryology of *Aurelia*, and his proof that the *Scyphostoma* larva, with its ectodermal œsophagus and four complete mesenteries, is of an Anthozoan nature, Mr. Wilson urges that his observations dispose of the view that what is seen in *Aurelia* is typical of the Anthozoa; he thinks that the symmetrical method has been derived from the gradual method seen in *Mancinia*, and he suggests that it may be connected with the reduction of the mesenteries to four. He is the more inclined to believe this, as an individual variation, seen in several larvæ, suggests the manner in which the condition found in *Aurelia* has been brought about.

Gorgonidæ of Naples.*—Dr. G. v. Koch commences his monograph on the Gorgonidæ of the Bay of Naples with some remarks on the structure of Alcyonarians in general. With regard to the mode of formation of colonies he points out that the stolons may arise only at the base of the polyp, and may be simple, as in *Cornularia*, or fused into basal plates as in *Rhizoxenia* and *Gorgonia*, or they may arise at different points of the polyp; these may be simple or fused into plates, as in *Telesto*, *Pennatula*, and *Gorgonia*, or the stolons may be irregular and fused into a massive tissue, as in *Alcyonium*, *Corallium*, and *Sclerogorgia*. There may be no skeleton as in *Moxenia*, or an investing ecto-

* Fauna u. Flora des Golfes von Neapel, Monogr. xv. (1887) 97 pp. (10 pls.).

skeleton only as in *Cornularia*, or a mesoskeleton only as in a number of forms, or both an exo- and a mesoskeleton. There are a few remarks on development.

The Alcyonaria are divisible into three suborders; the Alcyonacea are fixed, and have no independent axis formed by a continuous epithelial layer; the Gorgonacea are fixed, and have such an axis, but are not polymorphous, while the Pennatulacea are free, formed of a stalk and polyp-supports, with polymorphous polyps which are generally regularly arranged.

The suborder Gorgonacea contains only one family, that of the Gorgonidæ. An account is given of the form and colour of the whole colony, of the axial skeleton and epithelium, the cortex, the polyps, and the spicules. The species found in the Bay of Naples are described; these are *Gorgonella sarmentosa* and *G. Bianci*, *Muricea chamæleon*, *M. placomus* and *M. bebrycoides* (sp. n.), *Bebryce mollis*, *Gorgonia Cavolini*[*i*] (sp. n.), *G. verrucosa* and *G. profunda* (sp. n.), *Primnoa Ellisii*, and *Isis elongata*. Three analytical tables are given which are destined to aid the student in (1) recognizing the living animal, (2) determining complete colonies, and (3) making out species from fragments. In the last, of course, much assistance is obtained from the characters of the spicules.

Protozoa.

Direct Division of Nucleus in Euplotes harpa.*—Herr K. Möbius calls attention to the direct division of the nucleus during the transverse division of *Euplotes harpa*. This mode of division commences with the appearance of a row of cilia on the ventral surface; these are at first very delicate and short, and so are scarcely visible; they soon increase in size, and form a sigma-shaped row. While this has been going on the whole body has elongated, and become constricted in the middle. As the constriction grows deeper the new row of cilia passes completely to the hinder half, and forms its oral circlet. Other cilia appear, and the anterior half looks like a miniature of the mother-individual. The nucleus has the form of a sac placed transversely, gets thin in the middle, and finally divides into two elongated nuclei; there are no mitotic nuclear figures.

New Parasitic Infusoria.†—Mr. H. H. Anderson has described to the Microscopical Society of Calcutta a species of *Anoplophrya* which was found parasitic in the alimentary canal of *Æolosoma chlorostictum* (MSS. sp.); it divides by fusion (? fission), and "in some instances two septa have formed in a single organism."

Monograph of Tintinnodeæ.‡—Dr. E. v. Daday discovered at Naples a large number of new species of Tintinnodeæ, and he has written a monograph on the family.

After an historical introduction, an account is given of the test, of the external form of the body, and of the structure of its surface; this last is always ciliated, and in some species there are two kinds of cilia, some stiff, and some finer. In all marine, and probably also in fresh-water forms, the cilia are only arranged in four spiral rows. The

* SB. Gesell. Naturf. Freunde Berlin, 1887, pp. 102–3.
† Sci.-Gossip, 1888, p. 38.
‡ MT. Zool. Stat. Neapel, vii. (1887) pp. 473–591 (4 pls.).

peristome, which is a disc lying transversely to the long axis of the body, is next described; it has but a slight power of retraction, and is so far by no means comparable to the peristome of *Stentor* or *Vorticella*; the adoral ciliated plates aid in closing it. The account of the internal structure is divided into descriptions of the body-substance, the nuclei, and the vacuoles.

After some notes on their life-habits, the author passes to a systematic account of the forms that compose the family; *Amphorella*, and *Undella* are new genera, and twenty-nine new species are described.

Spore-formation in Peridineæ.*—Herr F. Schütt has made some observations on the development of Peridineæ, which appear to him to strengthen considerably the case against their being animals.

(1) He corroborates, in regard to *Ceratium fusus* and *C. furca*, the observations of Bergh on the division of *C. tripos*. (2) Quite distinct from the latter, a further process was observed which the author terms spore-formation. The protoplasm retracts, rounds itself off, and secretes a homogeneous sheath; the original case bursts, a pear-shaped "sporangium" issues, and divides into two. So far *Peridinium spiniferum* Clap. Lach. But in *Peridinium acuminatum* Ehrbg., a further evolution was observed. The daughter-cells, issuing from their sheath, were seen to rest for a few minutes and then exhibited a flagellum at one end. Herr Schütt therefore calls them "swarm-spores," and compares his results with the history of diatoms. Finally, he suggests that further observations will show that the naked forms of *Peridineæ*, e. g. Pouchet's *Gymnodinium gracile*, are simply stages in the history of encased forms.

Radiolaria.†—Under the title of part ii. of 'Die Radiolarien' Prof. E. Haeckel has published a 'Grundriss einer allgemeinen Naturgeschichte der Radiolarien,' which consists of the introduction to the 'Challenger' Report on Radiolarians, to which are appended a 'Catalogus Radiolarium,' and a 'Clavis Generum'; the latter based on the keys in the 'Challenger' Report. The seventy-four plates are a selection of those of the atlas of the report.

New Foraminifer.‡—M. J. Kunstler describes a remarkable new Foraminifer found at Arcachon. The adult has an ovoid monaxial test, one to two millimetres long, with the mouth at one pole; in youth the test is delicate, finely chitinous, and distinctly areolar in structure; it increases in thickness by the division of the areolæ into two, and then into several layers; the outermost and innermost layers remain chitinous, while the intermediate become charged with carbonate of lime, which forms a row of globules often arranged in regular lines. The increase in growth takes place throughout the whole thickness of the test, and so shows that the entire envelope is living. The protoplasm, which is areolated, does not always fill the whole of the test.

From the accumulation of protoplasm round the mouth, a variable number of fine transparent pseudopodia are given off; when these are all retracted, there may be seen a somewhat irregular excavation, at the bottom of which is the entrance to a tube, which, in appearance, is analogous to the œsophageal tube of a number of Infusoria. The nuclei

* Ber. Deutsch. Bot. Gesell., v. (1887) pp. 364–74 (1 pl.).

† 'Die Radiolarien (Rhizopoda Radiaria). Zweiter Theil. Grundriss einer allgemeinen Naturgeschichte der Radiolarien.' Folio, 1887, 248 pp. and 74 pls.

‡ Comptes Rendus, cvi. (1888) pp. 769–71.

vary greatly in form and number, and their appearance is coincident with the commencement of the reproductive period. Reproduction is effected by the formation of a chitinous layer around the mass of protoplasm which surrounds each nucleus; there are thus formed a number of small embryos which divide repeatedly as they increase in size; when they have acquired a certain size they escape by the mouth. A free young form is provided with a chitinous test perforated by one pore, and contains a small external nucleus. Each embryonic chamber soon produces by budding a small elongated chamber which becomes rolled spirally round it; other chambers are afterwards produced till the organism resembles a *Miliola*. The spiral arrangement becomes irregular, and finally dendritic.

The author is of opinion that the adult forms of certain Foraminifers have been hitherto misunderstood, and that the condition in which all the chambers are continuous is sometimes an embryonic stage.

Nature of Opaque Scarlet Spherules found in many Fossilized Foraminifera.*—Mr. H. J. Carter gives an account of curious coloured bodies which he has observed in sections of various fossil Foraminifers. At their earliest distinguishable stage they are colourless or slightly opaque, indistinct, and situated simply "in the cells of an areolar structure which fills the chamber of the Nummulite." Others are more defined, adherent to each other or clustered; others are more separated, semitransparent, and of a brown colour; finally, they present themselves as opaque scarlet spherules. These last vary from 1/600 to 1/7000 in. in diameter, and they are always confined to the sarcodiferous cavities of the test, so that they cannot be confounded with any inorganic mineralization. Mr. Carter cannot but regard these bodies as elements of reproduction, and compares them with similar bodies in recent specimens which differ in not being red (which is the effect of mineralization). No definite suggestion is offered as to the relation which the larger have to the smaller spherules.

New Species of Acineta.†—Mr. C. C. Nutting describes a new freshwater species of *Podophrya*, to which he gives the name *compressa*; most like *P. buckii*, it differs in having a distinctly compressed instead of cylindrical body, and in the possession of a short and thick pedicle. Observations on its mode of feeding did not support the ordinarily received doctrine that solid food is not ingested through the tentacles. A ciliated infusorian that had been seized as a prey was observed to have four incisions made into its ectosarc, and soon four rapid streams of protoplasm were observed passing into the body of the Acinetan; during the process solid coloured granules were seen to pass through the tentacles of the captor. This ingestion of solid material explains the apparent excretory function of the tentacles, for the *Podophrya* was observed on one occasion to violently eject a stream of granular protoplasm by one of its tentacles.

An account is given of the life-history of this form, and the fact that the writer was at first entirely misled by discovering a specimen with embryos clustered round its anterior end which appeared to have undergone exogenous gemmation, leads him to ask whether others have not

* Ann. and Mag. Nat. Hist., i. (1888) pp. 264–70.
† Amer. Natural., xxii. (1888) pp. 13–17.

been similarly deceived, and this mode of reproduction less common among Acinetans than is generally supposed.

Encystation of Megastoma intestinale.*—Prof. E. Perroncito finds that this monad undergoes encystation in the large intestine of *Mus musculus*. In the fæces cysts, perfect, or dividing specimens may be found. Dr. P. Blanchard † adds a note as to the nomenclature of the species, which he calls *Lamblia intestinalis*, as the generic term is already in use.

* Bull. Soc. Zool. France, xiii. (1888) pp. 16–8. † Loc. cit., pp. 18–9.

BOTANY.

A. GENERAL, including the Anatomy and Physiology of the Phanerogamia.

a. Anatomy.*

(1) Cell-structure and Protoplasm.

Nuclear Origin of Hyaloplasm.†—M. C. Degagny states that observers who are interested in the phenomena which accompany the indirect division of the nucleus, or karyokinesis, have asked if there is not in the nucleus, besides chromatic bodies, nucleoli, and nuclear sap, other plasmic matter which in certain cases is seen in the form of granulations, for example, in the nucleus of the mother-cell of the embryo-sac of the lily. If sections of the endosperm of the fritillary, lily, or iris be examined when the embryo-sac is not completely full, one finds all the nuclei of a certain region inclosing a hyaline matter which might be taken for an agglomeration of protoplasm; but this matter, which is very abundant in certain nuclei, is less so in others.

The author concludes by stating that the formation of carbohydrates and the formation of protoplasm are brought about by the dissemination or disorganization of nuclear substances. In the formation of protoplasm there are two distinct phases separated by a total change in molecular condition. In the first phase of its existence the fundamental protoplasm retains the crystalline form, like homogeneous inorganic substances in which the cohesion is uniform. In the second phase it is reorganized, and passes into the colloidal or amorphous state.

Three Nuclei in Pollen-grains.‡—Mr. B. D. Halsted describes the structure of some pollen obtained from *Sambucus racemosa*. When viewed dry, the pollen-grains are about twice as long as broad, and exhibit three dark longitudinal lines or sutures. For germination, fresh pollen was placed in a 10 per cent. solution of cane-sugar; and by means of the colouring substances eosin and azo-rubin, the author was able to determine the presence of three nuclei in nearly all the tubes. When only two nuclei were found in a grain or its tube, one was frequently larger than the other. This fact led to the suggestion that the larger or vegetative nucleus may undergo a process of division early in the development of the pollen-grain.

Nuclear and Cell-division.—Herr E. Zacharias § contests the view of Strasburger and Berthold, ‖ that, during the division of the nucleus, while it is passing over into the spindle-condition, the cell-protoplasm enters it, so that a sharply defined nucleus no longer exists, but the sections of its framework lie free in the cytoplasm. The observations were made on pollen-mother-cells of *Hemerocallis* and *Tradescantia*, epidermal cells of *Tradescantia*, and rhizoids of *Chara*, the latter in a living condition.

Zacharias finds that the nucleus does not give up its individuality

* This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents (including Secretions); (3) Structure of Tissues; and (4) Structure of Organs.

† Bull. Soc. Bot. France, xxxiv. (1887) pp. 365–72.

‡ Bot. Gazette, xii. (1887) pp. 285–8 (1 pl.).

§ Bot. Ztg., xlvi. (1888) pp. 33–40, 51–62 (1 pl.).

‖ See this Journal, 1887, p. 420.

during division. But, while chlorophyll-grains are simply bisected by a central constriction, during the division of the nucleus a portion of the parent-nucleus is not taken up into the daughter-nuclei, but is absorbed into the cytoplasm. Only its framework passes entirely into the daughter-nuclei, a portion of the matrix of the parent-nucleus does not. The author also differs from Strasburger's view that the combining-threads are partially identical with the spindle-fibres which originate from the cytoplasm that penetrates into the nucleus.

With regard to the formation of the cell-threads and cell-plate, the author dissents from the conclusion of Berthold, and maintains that the cell-threads originate in the barrel-shaped residue of the old nucleus between the separated filament-segments; the spindle-threads can still be recognized in the residue. The nature of the cell-plate was made out best in living rhizoids of *Chara*. The elements of the cell-plate travel from the surrounding cytoplasm into the residue of the parent-nucleus; the longish bodies from which essentially the cell-plate is constructed stand in no demonstrable relation to the fibres which are visible in the homogeneous body after treatment with reagents.

Zacharias identifies the process here described with the "perfect karyokinesis" of Carnoy.

With regard to the function of the cell-nucleus, the author was unable to come to any definite conclusion. At least at certain times in the life of the cell, when the nucleus is dividing, considerable quantities of albumen pass out of it into the cytoplasm.

To the above Herr G. Berthold replies,* maintaining the correctness of his statements, in opposition to those of Zacharias. The coalescence of the matrix of the old nucleus with the cytoplasm is very gradual, but still is distinctly demonstrable.

Herr Zacharias further replies† to several points in Schwarz's rejoinder to the criticisms of Zacharias on his paper on the morphological and chemical composition of protoplasm.

Structure and Growth of the Cell-wall.‡—Herr G Krabbe has investigated several points in the structure and mode of development of the wall of cells, of which the following are the more important details:—

With regard to the spiral striation of bast-fibres, the author agrees with Dippel (in opposition to Nägeli), that it is never the result of the crossing of two systems in one plane. This is seen especially on transverse section, where the striation-systems appear as radial lines, which alter their position on a change in the focus.

The mode of increase in thickness in the walls of bast-cells was investigated especially in the Apocynaceæ and Asclepiadeæ. Krabbe follows Strasburger in describing the wall as composed of distinct layers, themselves made up of lamellæ. The separate lamellæ, which are especially distinguished by variations in the striation, arise by fresh formations from the protoplasm, at first only loosely attached to the older parts of the cell-wall, but always sharply separated from the protoplasm, and showing distinct cellulose-reaction. It is probable that the separate lamellæ are all formed by new formation, and that increase in thickness from intussusception can only play a subordinate part, and must be confined to the innermost lamellæ.

* Bot. Ztg., xlvi. (1888) pp. 153–7.

† Ibid., pp. 69–75, 90–2. Cf. this Journal, *ante*, p. 69.

‡ Pringsheim's Jahrb. f. Wiss. Bot., xviii. (1887) pp. 346–423 (5 pls.).

The inequalities in the radial diameter of older bast-cells in Asclepiadeæ and Apocynaceæ does not result from constriction or compression of the narrower, but from a later widening of the broader part, which is always accompanied by a new formation of lamellæ of cellulose, commencing usually with the formation of fine transverse lamellæ and caps. Remains of protoplasm could often be detected between the separate cap-like pieces. A very distinct formation of caps takes place also at the ends of the bast-cells of *Euphorbia palustris*.

The local widenings of bast-cells can be explained only on the supposition of a superficial growth depending on intussusception. This the author claims to have proved by measurements, which show that the superficial increase could not be the result of simple stretching of the cell-wall.

The spiral striation of bast-cells the author believes to be always the result of subsequent differentiation in an at first homogeneous cell-wall, which advances in a centripetal direction. Besides this spiral striation, he observed in bast-cells a transverse stratification resulting from actual differentiation of the substance of the cell-wall. This differentiation also arises at a late period, but is said again to disappear in older bast-cells.

As a general result, the author concludes that, in addition to growth by apposition and by intussusception, there is also a periodic fresh formation of cell-wall, proceeding exclusively from the protoplasm, and independent of the portions of cell-wall already in existence. This new formation is not always accompanied by a contraction of the protoplasm, as is shown by the inclusion of masses of protoplasm in the formation of caps. But the caps do not always show the same chemical reactions, and it is probable that at later stages they are sometimes permeated by albuminoids.

Growth of the Cell-wall.*—From the experimental application of staining reagents, Dr. F. Noll has come to the conclusion that the mode of growth of the cell-wall is chiefly by apposition, while of the part played by intussusception there is no definite proof. The experiments were made chiefly on unicellular Siphoneæ, species of *Bryopsis* and *Derbesia*, by causing the production of Berlin blue in the cell-walls of the growing plant by the use of potassium ferrocyanide and iron chloride. The apical growth, however, takes place by a kind of "eruption"; the old membrane bursts, and the membrane of the young shoot is formed entirely of new material. The growth of the "leaves" of *Caulerpa* takes place especially in this way. From the fact that no surface-growth of the cell-wall has been observed independent of turgidity, the author concludes that a growth by apposition may be hereafter experimentally proved in the case of the cells of the higher plants similar to that which he has demonstrated in some Siphoneæ.

Morphology and Physiology of the Cell.†—As a section of the third volume of Schenk's 'Handbuch der Botanik,' Herr A. Zimmermann publishes an exhaustive treatise on this subject. After a general introduction he treats of the following subjects:—The form of the protoplasmic body, the finer structure and chemical composition of the

* Abhandl. Senckenberg. Naturf. Gesell., xv. (1887) pp. 101–62 (1 pl.).

† Zimmermann, A., 'Die Morphol. u. Physiol. der Pflanzenzelle,' 223 pp. and 36 figs., Breslau, 1887.

cytoplasm, the nucleus and chromatophores, cilia, and "eye-spot," the "bacteroids" and ciliated bodies of the Characeæ, protein-grains and crystalloids, the starch-grains and nearly related structures, such as the starch of the Rhodophyceæ and Phæophyceæ, amylon and cellulin, the various other cell-contents, cell-sap, and cell-wall. Finally, the various phenomena of the physiology of the cell are discussed.

(2) Other Cell-contents (including Secretions).

Formation of Aleurone-grains.*—According to observations of Herr J. H. Wakker, aleurone-grains are not, as has been generally stated, dried masses of protoplasm; but, at least in many cases, are vacuoles filled with soluble albuminoids; and hence the crystals, crystalloids, and globoids found in them are not formed in the protoplasm, but within the cell-sap. The investigations were chiefly made on a large number of seeds. In the process of germination the aleurone-grains first become vacuoles by the absorption of water, the albumen then gradually disappears from them; the vacuoles usually become smaller, and finally the globoids and crystalloids are dissolved. The crystalloids of *Derbesia Lamourouxii* were also found to have their origin in the cell-sap.

Elaioplast.†—Under this term Herr J. H. Wakker describes nearly globular strongly refringent yellow bodies which he finds, in addition to the colourless amyloplasts, in epidermal cells of the leaves of *Vanilla planifolia*. They exceed in size both the amyloplasts and the nuclei, having a diameter of 8–10 μ in the half-formed leaf. Treatment with a 10 per cent. solution of nitric acid coloured by eosin shows these bodies to be outside the vacuoles; a concentrated solution of picric acid, acetic acid, sulphuric acid, and potash lye, cause the exudation from these bodies of strongly refringent oil-drops, as does also simply warming. The oil-drops are coloured dark brown or black by a 1 per cent. solution of osmic acid, a beautiful red by tincture of alcanna, and blue by cyanin; absolute alcohol dissolves them gradually.

The elaioplasts are formed gradually in the epidermal cells during the development of the leaf. The author found them also in *Vanilla aromatica*, but not in *Cypripedium latifolium*.

Structure of Starch-grains.‡—Herr K. Mikosch has applied the same mode of investigation to the discovery of the ultimate structure of starch-grains as that employed by Wiesner § in determining the structure of the cell-wall. By laying for months in a 2 per cent. acid, hydrochloric, sulphuric, or chromic, or by the application of chlorine-water and subsequent pressure, he was able to break up potato-starch-grains into radial apparently homogeneous rods. Five weeks' action of 2 per cent. hydrochloric acid produced no change except a slight swelling, and rendering the stratification more conspicuous. In about three months the breaking up of the starch-grains into minute but sharply defined rods has been nearly completed. The processes are nearly the same in wheat-starch, but here the ultimate particles are granules, which can be made visible by simply warming in water of 45° C.

The author concludes that the starch-grain is composed of minute

* Maandbl. v. Natuurwetensch., 1887. See Bot. Centralbl., xxxiii. (1888) p. 361.
† Maandbl. v. Natuurwetensch., 1887. See Bot. Centralbl., xxxiii. (1888) p. 139.
‡ Mikosch, K., 'Unters. üb. d. Bau d. Stärkekörner,' Wien, 1887, 17 pp. and 5 figs.
§ See this Journal, 1886, p. 818.

but still visible *amylosomes*, imbedded in a homogeneous watery matrix which swells up easily. This matrix is coloured blue by iodine, but the extreme minuteness of the amylosomes rendered it difficult to determine whether this was the case with them also. He was unable to detect in the starch-grains the presence of any albuminous substance. The amylosomes when isolated are singly, but in their natural position doubly refractive.

Function of Tannin.*—Prof. W. Hillhouse states that in all its forms tannin is characterized by a weak acid reaction and an easily recognizable astringent taste. Although it is convenient to speak of the group under a single name, it must be borne in mind that the term includes a considerable series of bodies of slightly varying character, and our knowledge of which is still extremely limited. Most of them appear to be glucosides of gallic acid, and to be capable of resolution into gallic acid and glucose; those which give the blue-black reaction with ferric salts as a rule yield pyrogallol, while those which give the iron-green reaction commonly yield pyrocatechin. As regards the general chemistry of tannin, two conclusions may be drawn, viz. (1) that tannin is richer in carbon and oxygen than are carbohydrates, and (2) that either free, or in comparatively loose combination with it in the vegetable tissues, is an uncertain percentage of glucose. The author conducted his experiments upon the following lines:—(1) To determine whether the quantity of tannin in stems diminishes *pari passu* with the increase in the quantity of starch; (2) whether in spring the quantity of tannin increases as that of starch decreases; (3) whether in germination and in stems in spring tannin is used up when the quantity of starch or other carbohydrate has reached a low point.

The author's experiments point to the conclusion that tannin, once formed, is not used up in the further processes of growth, except perhaps in the formation of resin; and in this the evidence completely coincides with the non-transfer of tannin from falling leaves, and from the leaves of evergreens in winter. The function of tannin may be in some way to protect the dead or dying parts of the plants from diseases due to the attacks of fungoid organisms; putting this on one side, evidence does not support the view that tannin acts as a food-material analogous to starch, glucose, or oil.

Formation of Oxalate of Lime in Leaves.†—Herr A. F. W. Schimper has made a detailed examination of the mode of occurrence and formation of crystals of calcium oxalate in the leaves of plants. Only rarely, as in some families of mosses and in most ferns and grasses, does this salt appear to be entirely wanting in the cell-sap. When the crystals take the form of raphides, they are fully formed in the young leaves while still growing; but in the far larger number of cases where the crystals of calcium oxalate take some other form, the quantity is very small in young leaves, gradually increasing with age. An exceedingly good instance of this gradual increase with age is furnished by the leaves of *Acer Negundo*.

Distinguishing the crystals formed during growth as primary, and those formed after growth has been completed as secondary, the primary crystals are formed independently of light, while the formation of the

* Midl. Natural., x. (1887) pp. 269–76, 305–9; xi. (1888) pp. 5–11, 32–5.
† Bot. Ztg., xlvi. (1888) pp. 65–9, 81–9, 97–107, 113–23, 129–39, 145–53.

secondary is dependent on light and on the presence of chlorophyll. Leaves exposed to sunlight contain much larger quantities of this salt than those that remain in the shade. Cells destitute of chlorophyll may contain large quantities of the oxalate if the material for their formation is afforded by adjacent green cells. The formation of secondary calcium oxalate is therefore independent of assimilation. The salt can be transferred from place to place with great facility, and this takes place especially from the leaves into the stem.

The presence of lime appears to be essential for the conduction of the carbohydrates. The origin of the lime in the secondary oxalate is unquestionably the decomposition of the nitrates sucked up by the plant from the soil, the nitrogen being assimilated, and the secondary calcium oxalate remaining behind as a useless secondary product of assimilation. Leaves growing in the shade are found to contain larger quantities of undecomposed nitrates than those exposed to sunshine.

Crystals of Calcium oxalate.*—Herr J. H. Wakker has investigated the origin of crystals of calcium oxalate in a large number of cases where they are formed in the interior of the cell; and finds that they are not, as is usually supposed, formed in the protoplasm, but in the cell-sap, and are therefore without any direct relation to the life of the plant. By the use of either a 4 per cent. solution of cane-sugar, or a 10 per cent. solution of potassium nitrate with eosin, by which the outer protoplasm is killed, while the walls of the vacuoles are left intact, the formation within the vacuoles was demonstrated in the case of a large number of raphides and a smaller number of clusters of crystals, octohedra, granules, and amorphous masses. Although formed in the vacuoles, the crystals are sometimes carried along by the currents of protoplasm.

Position and Number of Raphides.†—According to Herr J. Eiselen, the size of the bundles of raphides varies about 5-fold in plants examined belonging to several different natural orders; the smallest bundles were found in the Ampelideæ, the largest in the Onagraceæ. The number of bundles in a unit of surface also varies in a manner characteristic of the family; the Mesembryanthemaceæ exhibited the smallest, the Balsamineæ the largest number. The position of the raphides is not so characteristic from a systematic point of view as their number or size. Nyctagineæ and Balsamineæ exhibit peculiarities in the position of the bundles in the spongy and palisade-parenchyma. In *Fuchsia*, which differs in this respect from other genera of Onagraceæ, the raphides surround the veins as a sheath.

Spring-sap in the Birch and Hornbeam.‡—Herr R. Hornberger has studied the composition of the sap exuding from the trunk of these trees by "bleeding" in the spring. The incisions were made at various heights from the ground. In both cases the sap contains levulose, with some dextrose, nitrogen, malic acid, and salts.

The amount of sugar was found, in the case of the birch, first to increase and then to diminish, from the commencement of the bleeding. The same was the case with malic acid, but to a less extent. The proportion of malic acid was, on the average, higher during the night than in

* Maandbl. v. Natuurwetensch., 1886. See Bot. Centralbl., xxxiv. (1888) p. 360.

† Eiselen, J., 'Ueb. d. systematischen Werth der Rhaphiden in dikot. Familien,' 27 pp., Halle, 1887.

‡ Forstliche Blätter, 1887, 16 pp. See Bot. Centralbl., xxxiii. (1888) p. 227.

the day. The hornbeam contains less sugar and acid than the birch; but the general results did not differ greatly. Incisions made at different heights showed that the upper portion of the trunk contained about twice as much nitrogen as the lower portion; the greater part was in the form of non-albuminoid nitrogenous substances. The hornbeam contained less nitrogen than the birch. The proportion of mineral substances in the birch steadily increased, the upper sap containing more than the lower, and the proportion being greater in the day than in the night. The upper sap contained more potassa, lime, and magnesia than the lower; there was only a very small quantity of iron, but a perceptible amount of manganese. Nearly all the sugar disappears before the hornbeam ceases to blossom, while it still appears in the birch until the blossoming is completed.

(3) Structure of Tissues.

Endosperm.*—Prof. G. S. Boulger alludes to the ambiguity in the use of the term endosperm. In Prof. Goebel's 'Outlines of Classification and Special Morphology,' it appears with three, if not four, somewhat disparate significations. To obviate this, the author proposes the term "archisperm" for those structures formed before fertilization, or at an early stage in the macrospore, viz. the meniscus-shaped "primary" (female) prothallium above the diaphragm in *Selaginella*, the so-called "endosperm" in Gymnosperms, and the antipodal cells of Angiosperms, and either to reserve the term "endosperm" or to use "metasperm" for those formed at a later stage, viz. the large-celled "secondary prothallium" below the "diaphragm" in *Selaginella*, the "secondary endosperm" in Gymnosperms, and the endosperm originally so called, formed after fertilization by the division of the secondary nucleus of the embryo-sac in Angiosperms.

Formation of the Duramen.†—According to M. E. Mer, the heart-wood or duramen is distingu shed from the wood of the peripheral region (alburnum) by its being more deeply coloured, and by several special industrial qualities. The duramen is often very apparent, as in the oak, chestnut, &c., while in other trees this region is either indistinct, or its dimensions are variable and its boundaries ill-defined. In some cases the existence at all of heart-wood has been denied (as in the beech, maple, fir-tree, &c.), the wood of the centre and of the periphery possessing, for industrial purposes, almost identical qualities. But if a fresh section be examined with care, the central portion will be found to possess a deeper tint, especially if it be taken from near the base of the tree.

The author gives the following as the principal results of his researches on the duramen.

(1) The duramen does not differ from sap-wood either in structure or in more advanced lignification, or in the existence of a colouring matter, but only in the presence of a quantity of tannin or in some cases of tannin and resin.

(2) The characters which distinguish the heart-wood from the sap-wood always exist, although the extent may vary.

* Journ. of Bot., xxvi. (1888) pp. 37–9.
† Bull. Soc. Bot. France, xxxiv. (1887) pp. 341–63.

(3) The tannin which is found in the heart-wood appears to be formed by the transformation of starch.

(4) Whenever an accumulation of starch is found in a woody tissue, it is either because the migration of this substance has been stopped, or because there is in the tissue an excess in quantity beyond the use that can be made of it.

(5) Tannin oxidizes on contact with air, and the colour is deepened.

(6) This oxidation of the tannin contained in the wood proceeds spontaneously, following the growth in age of the tree.

Diaphragms in the Air-canals of the Root.* — M. C. Sauvageau states that vascular plants which live in damp places or in water nearly always possess air-canals intercepted by transverse diaphragms situated in the middle region of the cortex; only, until the present time, the air-canals of the root were supposed to be destitute of these diaphragms.

In the course of a series of researches on the comparative anatomy of aquatic plants, the author found, in the root of *Hydrocharis morsus-ranæ*, diaphragms similar to those in other parts of the plant. The lacunæ or air-canals are parallel to one another throughout the length of the root; the diaphragms, which can be seen in either a transverse or longitudinal section, are sometimes oblique to the direction of the root, but more often they are at right angles to it.

Oil-passages in the Roots of Compositæ.†—Herr Triebel finds oil-passages in the roots of thirty-one species of Compositæ examined belonging to the groups Cynareæ and Radiatæ. They are always of schizogenous origin, resulting from tangential division of the endoderm, with which they usually continue in direct contact. In *Inula Helenium* similar structures occur in the middle of the root.

Effects produced by the Annular Decortication of Trees.‡—M. H. Lecomte states that the annular decortication of trees brings about several important changes in the manner of growth. The stem, the leaves, and the fruit are made by this mutilation the seat of an exaggerated development; the liber also grows more strongly in proportion to the other tissues, and there can be no doubt that decortication, while suspending the passage of substances elaborated in the green organs, produces hypertrophy of the upper parts, and causes an arrest in the development of organs situated below the mutilation.

Systematic Value of the Perforation in the Walls of Vessels.§— Dr. Solereder discusses the value of the different modes of perforation of the walls of true vessels and of tracheïdes from a systematic and phylogenetic point of view.

The tracheïdes of the Vascular Cryptogams exhibit what must be regarded as the primary type of perforation, viz. that with scalariform pits. True vessels occur only in a few isolated cases in Vascular Cryptogams. In Gymnosperms they are confined to a single order, the Gnetaceæ. In almost all Coniferæ and in Cycadeæ, the xylem consists entirely of tracheïdes; the medullary rays and the phloëm of the

* Comptes Rendus, cvi. (1888) pp. 78–9.

† Nov. Act. K. Leop.-Carol. Akad., l. (1887) 32 pp. See Bot. Centralbl., xxxiii. (1888) p. 201.

‡ Morot's Journ. de Bot., i. (1887) pp. 266–70, 273–8.

§ Bot. Ver. München, March 21, 1887. See Bot. Centralbl., xxxiii. (1888) p. 315.

vascular bundles of prosenchymatous and parenchymatous cells. In some Coniferæ bordered pits occur in the parenchyma of the medullary rays, which is never the case with Dicotyledons. The true vessels of the Gnetaceæ are constant in all the three genera, *Ephedra*, *Gnetum*, and *Welwitschia*; the perforation of the wall is in the form of circular pores, arranged in one or two rows; in *Gnetum* scalariform and elliptical perforations also occur.

In Monocotyledons we find simple and scalariform perforations. In Dicotyledons, simple perforation preponderates greatly in comparison with the scalariform; this latter is exclusively characteristic only of some small families, such as the Hamamelideæ.

Anatomy of the Leaf-stalk.*— Herr C. Plitt has examined the structure of the leaf-stalk in 283 plants belonging to thirty different families, with the view of establishing whether it can be used for purposes of classification; but the results are chiefly negative.

The configuration of the vascular bundles of the petiole may be either symmetrical or unsymmetrical; and in the former case the bundles form either a closed or an open system; and of both these a number of variations occur. In the open system the line of symmetry bisects the central bundle, which is often much larger than the others. The closed system may exist either as a central ring of distinct bundles, or as a central fibrovascular mass with compact xylem and closed cambium-ring.

The various types of petiole do not coincide with the various types of stem.

Permeability of the Epidermis of Leaves to Gases.†—M. L. Mangin, as the result of a number of experiments, comes to the conclusion that—

(1) The permeability of the epidermis of aerial leaves is very limited, but is greater for plants with deciduous than with non-deciduous leaves.

(2) When the surfaces are unlike, the permeability of the lower surface of the leaf is greater than that of the upper; it may be no more than one-third more, but may be five times as much.

(3) The permeability of the epidermis of submerged leaves without stomata, is very great, and may be as much as twenty times that of the most permeable aerial leaves.

(4) Where the surfaces of the leaves are waxy, the permeability is much diminished by the waxy material.

Epidermal Reservoirs for Water.‡—M. J. Vesque adds some fresh ones to his previous observations on the adaptation of the epidermis for the storing up of water. This was shown by the fact that when the epidermal cells were placed in nitric acid not sufficiently concentrated to produce plasmolysis (2–3 per cent.), or when exposed to excess of transpiration over absorption of water, they decreased in volume. The plants in which this was found to take place were *Lilium candidum*, *Tropæolum majus*, *Clematis Vitalba*, *Euonymus japonicus*, *Prunus Laurocerasus*, and others.

* Plitt, C., 'Beitr. z. vergleich. Anat. d. Blattstieles d. Dikotyledonen,' 52 pp. and 1 pl., Marburg, 1886. See Naturforscher, xxi. (1888) p. 90.

† Comptes Rendus, cvi. (1888) pp. 771–4.

‡ Ann. Agronom., xii. pp. 497–521. See Bot. Centralbl., xxxiii. (1888) p. 137. Cf. this Journal, 1887, p. 261.

Comparative Anatomy of Ambrosiaceæ and Senecioideæ.* — The examination of a large number of species belonging to these families leads Herr H. Hildebrandt to the conclusion that a great many nearly related species can be clearly and sharply distinguished by their anatomical structure. Points of anatomical structure may therefore be used for purposes of classification; but the divisions thus established do not coincide with those founded on morphological characters. Many species have an altogether abnormal structure; thus *Rhynchopsidium* and *Leyssera* resemble Cruciferæ.

Anatomy of Marcgraviaceæ.†—In an account of the anatomical structure of this natural order, Herr O. Juel states that sclerides, either isolated or associated in groups, occur commonly in the parenchymatous tissue. The order is distinguished by its dimorphic branches, erect fertile, and creeping sterile. The larger leaves have no stomata, while the smaller leaves have stomata on both surfaces; in the larger leaves the chlorophyll-grains have a diameter of 5–9 μ; in the smaller leaves they are about 20 μ long and 10 μ broad. The ovules are very small, with two integuments, of which the inner one projects far beyond the other, the apex emerging almost unchanged outside the testa of the ripe seed.

(4) Structure of Organs.

Vegetative Organs of Brasenia peltata.‡—Mr. J. Schrenk describes the structure of the vegetative organs of *Brasenia peltata* Pursh., a plant belonging to the natural order *Nymphæaceæ*. What is described in the manuals as the creeping rootstock is really a system of runners that proceed from the rhizome proper. The secondary roots arising at the nodes are long and slender; at the tip of each rootlet there is a sheath or case which looks exactly like the finger of a glove; it consists of a single layer of elongated oblong cells, forming a distinct firm membrane with an unbroken smooth rim. There is a central very thin plerome surrounded by thin-walled endoderm cells; the other root-tissues are very loose, with large intercellular canals, and a thin epidermis. In the stem the central portion is invariably occupied by two fibrovascular or mestome bundles. The two mestome bundles are separated by parenchymatous tissue, and groups of intercellular canals.

The leaf is thick, oval, and peltate, and has at most twenty principal veins, converging at the centre over the petiole. The cells of the upper epidermis have a peculiar structure; they are two or three times as high as they are broad. The palisade-tissue underneath the epidermis is composed of two or three, sometimes even four tiers of cylindrical, narrow cells, with numerous air-spaces between them, and containing, on their vertical walls, large chlorophyll-grains. If the epidermis of parts of this plant which are in contact with water be examined, it will be found to be thickly beset with hairs. The hairs are all unicellular, but vary much in size and shape; some divide into two equal or unequal branches; others again expand horizontally in the upper portion. By these hairs a mucilage peculiar to *Brasenia* is produced.

The author gives the results of a series of experiments with various

* Hildebrandt, H., 'Beitr. z. vergleich. Anatomie der Ambrosiaceen u. Senecioideen,' 52 pp. and 1 pl., Marburg, 1887.

† Bot. Sällsk. Stockholm, Feb. 16, 1887. See Bot. Centralbl., xxxiii. (1888) p. 27.

‡ Bull. Torrey Bot. Club, xv. (1888) pp. 29–47 (2 pls.).

reagents which he made in order to ascertain the structure of the hairs, and the nature of the secretion.

Formation of Roots in Loranthaceæ.*—Dr. C. v. Tubeuf has examined the structure and mode of formation of the roots in several exotic species of Loranthaceæ, viz.:—*Arceuthobium Douglasii*, parasitic on *Pseudotsuga Douglasii*, and *A. americanum* on *Pinus Murrayana* in America; *Viscum Kaempferi* on *Pinus densiflora* in Japan; *V. articulatum* on *Ligustrum japonicum*, and *Loranthus longiflorus* from India.

The species of *Arceuthobium* have cortical roots, with layers, but without the regularity of structure and arrangement of the layers on the cortical roots of the mistletoe. They cause not only a hypertrophy, but also a "witch-broom" formation, which is exceedingly destructive to the Douglas pine. *Viscum articulatum* has only a single root-disc, which grows in the cambium region of the host, interposing like a shell between the wood and the bast. *V. Kaempferi* and *Loranthus longiflorus* twine round the host, and put out roots which penetrate the bark into the wood. *Loranthus* has only a single growing point to the root, while the root of *V. Kaempferi* branches in the cambium region of the host like a many-fingered hand. The roots grow with great rapidity, spreading over a large space of wood in the course of a year, and putting out numerous lateral branches, which penetrate successively into all the subsequent annual rings of wood.

Root-hairs of the Rhinantheæ.†—M. Leclerc du Sablon, having examined the roots of *Melampyrum pratense*, which have been developed in a humid atmosphere, determined the existence of numerous hairs of very different dimensions; some the length of ordinary root-hairs, others much shorter, others again developed as small papillæ. In *Melampyrum* the parasitism has not done away with the normal organs of absorption.

Mycodomatia in the Roots of Papilionaceæ.‡—Herr A. N. Lundström accepts generally Woronin's interpretation of the swellings on the roots of Papilionaceæ, that they are caused by substances of a fungoid nature, which develope a kind of symbiosis advantageous to the plant in causing these structures to become reservoirs of food material. The tendency to produce these structures may, he thinks, become hereditary.

In specimens examined of *Trifolium repens*, he finds in the cells large numbers of active "bacteroids"; the number of these and the quantity of starch in the cell appear to be in inverse proportion to one another. They seem, in fact, to derive their sustenance from the starch-grains. The bacteroids are very transparent, not refringent, and are coloured a light yellow by chlor-zinc-iodide. The author considers that their very active movements cannot be due to molecular motion. They vary greatly in size, and become gradually more and more granular. Attempts to produce germination had negative results.

Morphology of Underground Stems.§—According to a number of observations made by Herr T. Bruck on both Monocotyledons and

* Bot. Ver. München, March 21, 1887. See Bot. Centralbl., xxxiii. (1888) p. 346.

† Bull. Soc. Bot. France, xxxv. (1888) pp. 81–2. Cf. this Journal, *ante*, p. 250.

‡ Naturv. Studentsällsk. Upsala, April 28, 1887. See Bot. Centralbl., xxxiii. (1888) pp. 159 and 185 (1 pl.). Cf. this Journal, *ante*, p. 251.

§ Progr. d. griech.-oriental. Ober-Realschule in Czernowitz, 1885, 14 pp. and 5 pls. See Bot. Centralbl., xxxiii. (1888) p. 168.

Dicotyledons, there is not in nature any sharp dividing line between the different kinds of underground stem described as bulb, tuber, root-stock (rhizome), &c. They pass into one another through a number of intermediate forms which it is difficult to classify.

Aerial Stems.*—M. L. Flot makes the following observations on the aerial stems of certain plants:—(*Ajuga reptans*, *Linaria spuria*, *Vinca minor*). The endoderm is more developed in horizontal stems. The fibrovascular bundles either early form a continuous arc, or their individuality disappears almost completely. The thickness of this arc is always more considerable than the corresponding part in vertical stems. The pith is less developed in horizontal stems. These facts entirely accord with those that have been described by M. Costantin.† The author, in conclusion, asks if it is not remarkable that absolutely comparable stems, living in the same surroundings, should have a different structure following the influence of geotropism?

Anatomy of Annual Branches and Inflorescences.‡—According to Herr J. Trautwein, there are no less than four distinct currents in a plant at the time of the unfolding of the leaves and flowers. The first carries up through the xylem the water and all inorganic substances dissolved in it. The second, the soft bast, is the medium for the transport of the nitrogenous substances or albuminoids. The third current, which conducts carbohydrates and oils, takes place chiefly through the cortical parenchyma. The author discusses in detail the relative development of the tissues through which these currents pass in the various portions of an annual stem. The general result of his observations is that all variations in the anatomical structure of the axial parts of plants are dependent solely on their usefulness and adaptability for the advantage of the organ in question. It is in this way that the flower acts on the axis which supports it.

Structure of the Leaves of certain of the Coniferæ.§—M. A. Daguillon calls attention to the well-known fact that in many of the Coniferæ the leaves inserted on the principal stem are different in appearance and in form from those borne by the lateral branches. The author has endeavoured to ascertain whether this external dimorphism corresponds to any difference of structure. In *Picea excelsa* the chief difference between the stem-leaves and the branch-leaves is that the latter are very much more flattened. The endoderm in the stem-leaves of this tree is composed of twenty-two cells, while in branch-leaves there are only sixteen. The liber and conjunctive parenchyma of the vein of the leaf are also represented by fewer elements in the branch-leaves.

Comparative Morphology of the Flower.‖—From the examination of flowers belonging to a large number of natural orders, Herr K. Schumann defends the older view that all the whorls of plants are foliar organs; all the known facts being reconcileable with this theory, which is also simpler than any other that has been proposed. He also adheres to the

* Bull. Soc. Bot. France, xxxv. (1888) pp. 54–6.

† Cf. this Journal, 1884, p. 252.

‡ Trautwein, J., 'Ueb. Anatomie einjähriger Zweige u. Blütenstandachsen,' 40 pp., Halle, 1885. See Bot. Centralbl., xxxiii. (1888) p. 201.

§ Bull. Soc. Bot. France, xxxv. (1888) pp. 57–61.

‖ Pringsheim's Jahrb. f. Wiss. Bot., xviii. (1887) pp. 133–93 (2 pls.).

theory that all gamophyllous whorls are the result of cohesion, this cohesion sometimes taking place in a very rudimentary condition of the organs. It may take place either in the collateral or in the serial direction, or in a combination of the two. The inferior ovary must be regarded as resulting from the serial coalescence of the members of the different whorls. If it is an axial structure, then all gamophyllous whorls must be considered to be tubular differentiations of the axis. All placentæ are organs of a foliar character.

Size and Colour of Alpine Flowers.*—From observations of a large number of Alpine flowers, Herr R. Keller has come to the conclusion that their larger size is generally comparative only to the size of the plant, not absolute; and that their conspicuousness is due to the intensity and other peculiarities of their colouring, such as the scarcity of white and yellow flowers as compared to red. The number of species of insect is not less than at low levels, but the number of individuals is very much smaller, and the favourable time for visiting flowers shorter. The greater intensity of colour of the flowers is partly due to a physical effect of light, which can be demonstrated by experiment.

Trigger-hairs of the Thistle-flower.†—Prof. B. D. Halsted describes the structure of the hairs found upon the filaments of the stamens of *Cnicus altissimus* Willd. Each trichome consists of two nearly parallel cells, which extend side by side to nearly the end of the outgrowth. There is a hyaline outer layer common to the two cells.

It is not difficult to determine the origin and development of these twin-celled hairs if the filaments are taken for study while young. The surface is at first smooth; in slightly older stamens small enlargements at certain places, where the surface cells meet end to end, may be recognized. The ends of these two cells now take on a lateral growth, and soon become bent at right angles to the surface of the filament.

These trichomes, therefore, originate by the lateral extension of the ends of two adjoining cells, and they evidently play an important part in the movements of the filaments.

Ovules of Plantago.‡—Prof. H. Baillon corrects previous descriptions of the position of the ovules in this genus. It varies remarkably in the different species. In *P. alpina* and *maritima* one of the two loculi incloses a single ovule at the upper part of the septum; the other contains two at the base. In *P. maxima* there are usually two ovules in each loculus a little above the base. In *P. arabica*, *Lagopus*, *saxatilis*, *Cynops*, *aristata*, *lanceolata*, and *Webbii*, there is one in each loculus above the middle. In *P. coronopus* there are two in each loculus, or four, of which two are imperfectly developed, or three, of which two stand lower than the others. In *P. subulata* the young pistil has three ovules in each loculus, one above the others and on the central line, the other two lower and lateral, with their backs turned to one another. In *P. major* there are 12–15 ovules in each loculus, or sometimes fewer, placed irregularly in several rows.

* Keller, R., 'Die Blüten alpiner Pflanzen, ihre Grösse u. Farbenintensität,' 36 pp., Basel, 1887.

† Bull. Torrey Bot. Club, xv. (1888) pp. 82–4 (2 figs.).

‡ Bull. Mens. Soc. Linn. Paris, 1887, p. 663. See Bot. Centralbl., xxxiii. (1888) p. 10.

Anatomy and Diseases of Aurantiaceæ.*—In a very exhaustive monograph of the twelve genera which constitute the Aurantiaceæ, Dr. O. Penzig discusses the morphology of the various organs, the physiological relationship of the species, the fruits and the organic substances found in them—citric acid, an ethereal oil, calcium oxalate, hesperidin, aurantiin, murrayin, æglein, decumanin, and limonin—and the diseases to which the crop is subject.

Of parasitic and saprophytic fungi on the Aurantiaceæ, Dr. Penzig enumerates 190, of which 12 belong to the Hymenomycetes, 4 to the Discomycetes, 109 to the Pyrenomycetes, 56 to the Hyphomycetes, and 2 to the Phycomycetes. There are, besides, 1 Myxomycete and 12 sterile forms of mycelium.

Morphology and Anatomy of Loasaceæ.†—Herr M. Greinert describes the peculiarities of this order, including about 100 species, especially in relation to the structure of the seeds, the germination, and the nature of the hairs. The embryo is always elongated, straight, and placed in the middle of the endosperm. The cotyledons are flat and plano-convex, and always lie with their flat sides in contact. The endosperm always contains large quantities of oil, but never starch. The very characteristic hairs are of different kinds: unicellular and multicellular, glandular, stinging, sharp-pointed, barbed, and silky. The anatomy of the stem and leaves shows a great uniformity throughout the order, although some of the species are herbaceous and others climbing.

Polymorphism attributed to certain generic groups.‡—M. F. Crépin queries whether the exceptional polymorphism which is attributed to certain genera is not more or less of a fallacy. The genera *Hieracium*, *Mentha*, *Rubus*, and *Rosa* are often quoted as examples of groups where excessive polymorphism exists, but these genera have been carefully studied by many generations of botanists. The degree of polymorphism accorded to a genus varies directly in proportion to the amount of analytical examination which has been devoted to the species and varieties of that genus; and the author considers that the exceptional polymorphism attributed to certain genera, and the stability of form attributed to certain other genera, have as yet not been sufficiently proved.

β. Physiology.§

(1) Reproduction and Germination.

Heterostylism and Self-fertilization.‖—Herr W. Burck finds a transition between dimorphic and trimorphic flowers in species of *Connarus* and *Averrhoa*. *C. Bankensis* and *diversifolius* are dimorphic, with rudiments of a second internal whorl of stamens which do not produce pollen. *C. falcatus* is trimorphic, but the inner whorl of stamens has smaller anthers and smaller pollen-grains. These anthers do not open,

* Penzig, O., 'Studi bot. sugli Agrumi,' 590 pp. and 58 pls., Rome, 1887.

† 'Beitr. z. Kenntniss d. morph. u. anatom. Verhältnisse der Loasaceen,' 58 pp. and 1 pl., Freiburg i. B., 1886. See Bot. Centralbl., xxxiii. (1888) p. 204.

‡ CR. Soc. R. Bot. Belg., 1888, pp. 39–47.

§ This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth (including Movements of Fluids); (3) Irritability; and (4) Chemical Changes (including Respiration and Fermentation).

‖ Ann. Jard. Bot. Buitenzorg, vi. (1887). See Bot. Centralbl., xxxiii. (1888) p. 260.

and the species is therefore functionally dimorphic. In *Averrhoa* also the dimorphic is derived from the trimorphic structure by the disappearance of the inner row of stamens. In Rubiaceæ and other instances it appears to have a different origin.

Species of *Cassia* have been described by H. Müller as having styles bending either to the right or left, and this he believed to be a contrivance for promoting cross-fertilization. Herr Burck adduces the reasons which have led him to an opposite conclusion, that the arrangement favours self-fertilization, and renders cross-fertilization almost impossible.

Fertilization of Calopogon parviflorus.*—Mr. C. Robertson describes the fertilization of *Calopogon parviflorus* Lindl., very common in the pine-barrens of Florida. Small bees (Andrenidæ), approaching the flower in front, light upon the crest, when the labellum bends suddenly, so that the dorsal surface of the insect comes down upon the column. The broad, slightly upturned wings of the column keep the body from passing to either side, and so require it to slip off the end. In doing this the body strikes the stigma, and becomes smeared with viscid matter. As the body slips off the end of the column the exposed ends of the pollinia strike the part which is smeared with viscid matter from the stigma, and the pollinia are drawn out and cemented to the exact spot which struck the stigma in the first place. When the insect visits another flower, the part to which the pollen is glued comes down upon the stigma.

Pollination of Alpine Plants.†—Herr C. Lindman describes the contrivances for promoting pollination in a number of plants from the Scandinavian Alps. They include species adapted for self- and others adapted for cross-pollination.

Pollination of Silene inflata.‡—Herr P. Magnus has observed that, while in the neighbourhood of Berlin this species is polygamous and trioecious (the hermaphrodite plants strongly proterandrous), at high altitudes near Zermatt it is always gyno-dioecious, with inconspicuous female and more conspicuous proterandrous hermaphrodite flowers. In the latter the corolla is very fully developed, and projects far out of the ventricose calyx, the flowers standing on long stalks. In the former the corolla scarcely projects beyond the calyx; the rudimentary stamens are sometimes petaloid. All the plants bore well-developed capsules with seeds, and the flowers must obviously have been pollinated by the agency of insects.

(2) Nutrition and Growth (including Movements of Fluids).

Physiological Oxidation in the Protoplasm.§—Herr W. Detmer maintains that the oxidation of difficultly oxidizable substances, such as sugar, which goes on in every living cell, is a process dependent on the vitality of the protoplasm in the living cell, and he proposes for it the term "physiological oxidation." In dead parts of plants experimented on immediately after death, he finds that no respiration or combustion of carbon takes place. The contrary conclusion of Reinke ‖ he attributes to

* Bot. Gazette, xii. (1887) pp. 288–91.

† Bot. Sällsk. Stockholm, May 4, 1887. See Bot. Centralbl., xxxiii. (1888) p. 58.

‡ Ber. Hauptvers. Bot. Ver. Prov. Brandenburg, June 5, 1887. See Bot. Centralbl., xxxiii. (1888) p. 136.

§ Bot. Ztg., xlvi. (1888) pp. 39–45. ‖ See this Journal, *ante*, p. 88.

the fact that the experiments of this writer extended over too long a period after the death of the parts of the plant in question, when the production of carbonic acid has set in, resulting from the presence of bacteria or ordinary putrefaction.

Assimilation in Plants destitute of Chlorophyll.*—Herr F. Hueppe has determined that a nitrifying bacterium which presents no peculiarities in the spectroscope, possesses the power of making use of the carbon in carbon dioxide for the production of carbohydrates, ammonium carbonate being broken up into ammonia, formic aldehyd, and oxygen; the oxygen thus set free then, in the nascent condition, oxidizing the ammonia into nitric acid, and causing the aldehyd to split up into cellulose and water. Whether sugar was formed in the first place was not determined.

Synthesis of Albuminoids.†—M. Chrapowitzki caused seedlings of *Phaseolus*, *Lupinus*, *Pisum*, *Cucurbita*, *Helianthus*, *Cannabis*, *Zea*, and *Pinus*, to use up the whole of their reserve albuminoids by water-culture in solutions of mineral salts containing no nitrogen. If then transferred to another solution containing nitrates, a gradual fresh formation of albuminoids may be observed in the chlorophyll-grains, commencing in from three to six days. The author concludes that the chlorophyll-grains are the seat of the formation not only of the carbohydrates, but also of the albuminoids.

Relation between the Heat and the Carbonic Acid given off by Plants in Respiration.‡—Dr. H. Rodewald has attempted to investigate, by means of caloria or chambers constructed for the purpose, the amount of heat given off by plants in the process of respiration, comparing this with the quantity of carbonic acid eliminated. The objects experimented on were ripening apples and potatoes. He finds that always by far the larger part of the energy set free by respiration is given off in the form of heat. Supposing the whole of the carbonic acid to result from the combustion of starch, he found the actual quantity of heat developed to be 92·2 per cent. of that which would be due theoretically to the consumption of the corresponding amount of starch. The contrivances by which the vitiation of the results through errors was prevented are described in detail. The loss of heat from transpiration could be estimated from the loss of weight, from which the quantity of carbon consumed in respiration must be deducted. The specific heat of the body experimented on was determined by a calorimeter to be about 0·924. The quantity of carbonic acid evolved was estimated at the same time in all the experiments.

Duration of the Apical Growth of the Leaf. §—Herr P. Sonntag discusses the correctness of the view that axial and foliar structures may be distinguished from one another by the difference in the mode of growth, whether basal or apical. The termination of apical growth may be inferred from the formation of hairs on the growing point, and from the development of intercellular spaces in the apical tissue.

Among Vascular Cryptogams we find that in most ferns apical growth of the leaves has ceased when all the lateral segments have been formed,

* Versamml. Deutsch. Naturf. u. Aerzte, Wiesbaden, Sept. 21, 1887. See Bot. Centralbl., xxxiii. (1888) p. 60.

† Bull. Acad. Imp. Sci. St. Pétersbourg, xxxii. (1887) pp. 96–8.

‡ Pringsheim's Jahrb. f. Wiss. Bot., xviii. (1887) pp. 263–345 (1 pl.).

§ Ibid., pp. 236–62 (1 pl.).

which may not take place until after the formation of the basal portion. To this there are some striking exceptions in the unlimited apical growth of the leaves of *Nephrolepis* and of some Gleicheniaceæ.

The Cycadeæ exhibit the same variation in this respect as ferns. Among Coniferæ, on the other hand, apical growth appears always to cease at a very early period.

In Monocotyledons the apical growth of the leaves is in general very limited, the intercalary growth being of far greater importance.

Among Dicotyledons three distinguished types of leaf-growth may be distinguished, viz.:—(1) Intercalary, where the lateral segments, whether pinnæ or teeth, proceed from a point which is not at the apex of the leaf; the apex soon passes into a resting condition, the growing point lying below it; (2) apical, where all the lateral segments of the first order proceed from the growing apex; and (3) an intermediate type, partaking of the characters of the other two. To the first type belong the leaves of the greater number of herbaceous and woody Dicotyledons. The lateral segments may arise in either basipetal or basifugal succession. Of the second type the most striking examples are the Umbelliferæ, most Leguminosæ (except the Acacieæ and Cæsalpinieæ), and some Filices and Cycadeæ. To the third type belong the leaves of a large number of Compositæ.

Influence of External Forces on the Form of Plants.*—Herr F. Noll discusses the question, What is the source of the energy which determines the varying growth and development of the different parts of a plant? If we take such a unicellular organism as *Caulerpa* and *Bryopsis*, the different parts of the single cell are differentiated physiologically, but not anatomically, since it is possible, by reversing the position, at once to convert the apex of the "stem" into a "root." There can be here no protoplasm peculiar to stem, leaf, or root, since the protoplasm, with its chromatophores and nuclei, is in constant motion from one organ to another, and cannot therefore determine the difference in the nature of the irritability of the different organs. This power must reside in a substance which remains permanently attached to each organ; and, since it cannot be referred to the cell-wall, it must belong to the quiescent parietal layer of protoplasm, which must be the seat of the properties of geotropism and heliotropism. The same argument applies also to the cells of the higher plants, where the granular protoplasm is in constant varying circulation or rotation, the parietal utricle alone remaining at rest. The continuity of protoplasm which has been demonstrated from cell to cell is a continuity of this active parietal homogeneous, not granular, protoplasm.

Transpiration as a Function of Living Protoplasm.†—Rev. G. Henslow gives the results of numerous experiments, from which he draws the following general conclusions:—That plants which do not possess chlorophyll at all transpire more under light than in darkness, but exhibit slight, but not very appreciable, differences under light of various colours. Transpiration appears to be more sensitive to increments of temperature than to colours, and perhaps than to pure white light itself. Etiolated plants still show some slight difference due to coloured rays.

* Versamml. Deutsch. Naturf. u. Aerzte, Wiesbaden, September 20, 1887. See Bot. Centralbl., xxxiii. (1888) p. 29.

† Journ. Linn. Soc. Lond.—Bot., xxiv. (1888) pp. 286-307.

In both cases transpiration is a function of living colourless protoplasm, this function, however, being greatly enhanced by the presence of chlorophyll.

The author made a number of experiments on transpiration in a saturated atmosphere, selecting *Buxus sempervirens*, *Ligustrum vulgare*, and *Epilobium hirsutum*, to represent three types of foliage. The result obtained was that, as long as the plants were exposed to diffused daylight they continued to lose weight, although the atmosphere was apparently perfectly saturated all the time.

Finally, the author gives the details of some experiments on evaporation in a saturated atmosphere. The results which he obtained prove that dead saturated substances continue to evaporate, notwithstanding that the atmosphere in which they are suspended is apparently saturated.

(3) Irritability.

Contractility of the Protoplasm of Certain Cells.*—Mr. W. Gardiner describes certain experiments made upon the pulvinus of *Mimosa pudica*. Transverse and longitudinal sections were cut under an aqueous solution of eosin, and it was found that the dye readily penetrated into and stained the protoplasm of the outer cells of the convex side of the pulvinus; the tract of cells situated towards the more external portion, the seat of the specially irritable tissue, was left unstained. Electrical experiments with the pulvini were then made. The wonderful delicacy with which the irritable cells of the pulvinus at once reply to stimulation suggest that in dealing with the movements of the pulvinus of *Mimosa* we have essentially to do with the phenomenon of contractility. Experiments were then made with an organism peculiarly sensitive to stimulation, viz. *Mesocarpus pleurocarpus*.

The author states in conclusion that there can be no doubt that the protoplasm of plant-cells, like that of animal-cells, is capable of active contraction, and he believes that in all irritable organs the movements are brought about in consequence of a definite contraction of the protoplasm of the irritable cells, and that during such contraction some of the cell-sap escapes to the exterior.

Movement of Leaf of Mimosa pudica.†—Dr. S. H. Vines has attempted to get some further information as to the nature of the mechanism of the movements of the leaf of *Mimosa pudica*. Experiments with atropin on the main pulvinus resulted in showing that movement of the petiole on stimulation becomes gradually less and less, until it ceases altogether, the petiole retaining the more or less nearly horizontal diurnal position; with the leaflets the induced movement is at first well marked, and they readily recover the expanded position; but gradually they failed to expand completely after stimulation, and at last remain completely closed. With physostigmin the effect on the main pulvinus is gradually to diminish the extent of recovery after stimulation, until eventually the pulvinus retains the position characteristic of stimulation; the closing movement of the leaflets becomes less and less marked, until finally they make no movement at all, but remain open.

The effect of atropin, then, is that of darkness, while that of physostigmin is that of light.

* Proc. Roy. Soc., xliii. (1887) pp. 177–81.
† Rep. Brit. Assoc. Adv. Sci., 1887 (1888) pp. 742–3.

The author concludes that it is the protoplasm which is the active agent in the movement of the leaves, and not the cell-wall or the cell-sap. It is not conceivable that the physical properties of the cell-wall, or the osmotic properties of the cell-sap, should be affected in such opposite ways by these alkaloids.

In the course of these observations Dr. Vines noted some points in the physiology of the movements of the leaves of *Mimosa* which seem to have been hitherto overlooked: the fall of the petiole is in no case caused by artificial darkness during the daytime, but takes place only in the evening, when the general tension diminishes; the secondary petioles are likewise unaffected by darkness during the daytime, and they are sensitive to mechanical stimulation only when the leaf is young.

Geotropism.*—Herr W. Saposhnikoff defends the older theory of Knight and Hofmeister, of the passive geotropic curvature of roots, against the new theory of active curvature. Roots from which the apex or heaviest part has been removed, are geotropic in the air, but show no curvature in water. Microscopic examination of the curved portions of roots show that the lower part of the cork-parenchyma of the root is thicker than the upper part. In the root, as in the stem, the lower part has a tendency to grow more rapidly than the upper part.

γ. General.

Cecidium of Nematus Capreæ.†—Herr M. W. Beyerinck states that the galls produced on various species of willow by the Tenthredineæ may be divided into two groups, one having a globular form and being connected with the leaf by a short stalk, the other forming a thickening on both the upper and under side of the leaf. To the former group belong the cecidium of *Nematus viminalis* on *Salix purpurea*, and that of *N. pedunculi* on *S. aurita*; to the latter that of *N. Capreæ*, which is most common on *S. amygdalina*, *alba*, and *fragilis*, less frequent on *S. babylonica* and *pentandra*.

Nematus Capreæ occurs in two generations. At the end of May the small saw-wasp pierces with its saw the young leaves in the terminal bud of *S. amygdalina*, making a triangular puncture in which the egg is laid, and the orifice is closed by a drop of mucilage from the poison-bladder. Hypertrophy sets up immediately in all the tissues of the leaf, and the gall attains its full development in from two to three weeks. By the end of June the larva pierces the gall, falls to the ground, and spins a dark brown cocoon, changing into a nymph-pupa, from which, in August, the second generation proceeds fully developed. This also seeks the shoots of the willow in which to lay its eggs; the animal goes through the same changes, but the cocoon is spun within the gall, which falls to the ground. In the first generation the males are entirely wanting, and are very rare in the second. Parthenogenesis appears to take place from generation to generation without any unfavourable results.

The formation of the gall appears to be caused neither by the egg, nor by the larva, but by the action of the drop of poison injected by the insect herself. The substance which produces the gall is not an ordinary albuminoid, but as is probably the case also with all galls, it has all the properties of a ferment.

* Schrift. Moskauer Univ., 1887, 21 pp. and 1 pl. (Russian). See Bot. Centralbl., xxxiii. (1888) p. 101. † Bot. Ztg., xlvi. (1888) pp. 1–11, 17–28 (1 pl. and 1 fig.).

B. CRYPTOGAMIA.

Alternation of Generations in Green Plants.*—Mr. J. R. Vaizey is of opinion that comparisons of the life-histories of *Coleochæte*, *Œdogonium*, *Sphæroplea*, *Hydrodictyon*, *Pandorina*, *Chara*, and the *Florideæ* with that of the lowest mosses show that in all these forms there is virtually an alternation of generations. In the lowest forms the sporophore generation consists of a simple mass of cells produced by the division of the oospore, and each cell becomes a spore which gives rise to the vegetative body of the oophyte; in *Pandorina*, which is the simplest case, the oospore sometimes gives rise directly to a single sexual *Pandorina* cœnobium, or by division to several spores, each of which gives rise to a sexual *Pandorina* cœnobium.

It is suggested that alternation of generations arose from polyembryony; if this be true, the sporophyte, as it is more generally known in the mosses and higher plants, is a new body originating among the higher Algæ and lower Liverworts not genetically connected with the sexual body; it follows that the tissues of the sporophyte cannot be homologous with those of the oophyte, though they may be analogous.

Thallophytes in Medicinal Solutions.†—Mr. R. G. Eccles states that most educated pharmacists are aware of the fact that aqueous supplies of medicine are subject to pollution during warm weather, even if prepared with what is ordinarily considered scrupulous care as to cleanliness. Unidentified forms of cryptogamic vegetation develope therein from spores supplied by the air, water, drug, or vessel. The author examined various preparations. In a sample of infected dilute phosphoric acid, long, branching, obscurely jointed filaments were the most conspicuous thing in sight. A closer inspection revealed the presence of living micrococci, and of somewhat larger bacteria, probably *Bacterium termo*. In cinnamon water only bacterial forms were seen, and these evidently decompose the essential oil. In sulpho-cyanate of potassium, carbonate of barium, and phosphate of sodium, organisms containing chlorophyll appear. In solutions of the salts of morphia the long stringy masses that invade other solutions of alkaloidal salts seldom, if ever, appear. Only motile bacteria and undetermined bacilli were developed.

Cryptogamia Vascularia.

Development of the Sporangium of Polypodiaceæ.‡—Dr. J. Kündig has investigated the history of the development of the sporangium in several species of Polypodiaceæ. He finds *Polypodium vulgare* to differ from all other members of the order in the first division-wall in the epidermal cell which ultimately developes into the sporangium being transverse; in all the other species examined it is oblique.

Paraphyses of two different kinds occur in the Polypodiaceæ:—(1) they spring from the surface of the receptacle among the sporangia, agreeing in their structure altogether with the trichomes on the under surface of the leaf; (2) from the stalk of the sporangium. In several species of *Aspidium*, e. g. *A. Filix-mas*, each sporangium bears one such paraphysis; while in some other species several spring from each sporangium-stalk,

* Rep. Brit. Assoc. Adv. Sci., 1887 (1888) pp. 771–2.
† Journ. New York Micr. Soc., iv. (1888) pp. 19–28.
‡ Hedwigia, xxviii. (1888) pp. 1–11 (1 pl.).

when they are always considerably smaller. They are often swollen and glandular at the apex, and may serve both as secretory and as protective organs. The view that these paraphyses are rudimentary sporangia is confirmed by the facts that they are sometimes found divided in the same way as true sporangia, that in *Aspidium Sieboldii* the sporangia are normally branched, and that in this species the paraphysis has been found replaced by a sporangium.

The origin and development of the sporangium agrees with that of the Polypodiaceæ in all essential points in the Cyatheaceæ, Schizæaceæ, Gleicheniaceæ, and Hymenophyllaceæ.

Stomata and Ligules of Selaginella.*—Prof. W. R. M'Nab reports that he lately exhibited leaves of *Selaginella densa* and *S. Poulteri*, showing a triple series of stomata developed along each margin. In leaves of seedling plants of *S. Kraussiana* the peculiar marginal stomata were also found to be present; they form three rows, one on the actual edge of the leaf, one on the upper, and one on the lower side; and in these three species the elongated sclerous cells which are often found on the margin of the leaf are wanting. The marginal stomata are easily demonstrated by carbolic acid, which renders the whole part exceedingly transparent. In such preparations the course of the fibrovascular bundles can be easily traced, and the relation of the ligule to the bundle clearly made out. The author suggests that the ligule is an organ of absorption.

Muscineæ.

Anatomy and Development of the Sporogonium of Mosses.†—Mr. J. R. Vaizey holds that the Muscineæ are not separated from the Vasculares by so great a gap as has been usually supposed.

The *Polytrichaceæ* are a favourable group for the examination of the structure of the sporogonium, as they are easily obtained, and their large size makes the examination of minute structure in them easier than in most of the other common orders of Musci. The author summarizes his conclusions as follows:—

(1) The tissues of the central strand in the cases investigated consist of two kinds, the leptophloem whose function is inferred on anatomical grounds to be similar to that of the phloem of Vascular Plants, and the leptoxylem, the function of which was originally inferred on anatomical grounds, but has lately, by direct experiment, been determined to be that of conducting the transpiration current up the seta.

(2) The apophysis of the sporogonium of the Polytrichaceæ is an organ for assimilating and absorbing gases, and that transpiration takes place from it must be evident from its anatomy; and it is in this respect similar to the leaves of vascular plants.

(3) The foot (the portion of the sporogonium placed within the vaginula) is the organ of absorption of fluids, although it does not present the ordinary form of a root, as it does not show any sign of endogenous structure.

The author suggests that the root of *Phylloglossum* may form a connecting link between the foot of the Muscineæ and the root of the Vasculares.

* Rep. Brit. Assoc. Adv. Sci., 1887 (1888) pp. 743–4.

† Journ. Linn. Soc. Lond.—Bot., xxiv. (1888) pp. 262–85 (4 pls.). Cf. this Journal, *ante*, p. 91.

Internal Peristome of Mosses.*—M. Philibert continues his studies on the structure of the peristome. He states that the internal peristome is always constructed on one general plan, except in the Funariaceæ; nevertheless in the various genera, and even between the species, certain differences in its structure exist. The dorsal network is always the same, although more or less apparent; but the meshes of the ventral network vary in number and form. This form is usually more or less trapezoidal, but they are often pentagonal or hexagonal. The number of rows corresponding to each of the teeth is also very variable; in the genus *Mnium* there are four or five, while in most of the Hypnaceæ there are only three or four. Other differences result from the entire absence or from the feeble dimensions of certain elements in the normal structure. The author then describes in detail the structure of the internal peristome as found in the Meeseæ. In this group of mosses the peristome has exactly the same origin as in *Mnium* and *Bryum*, and its elements are disposed on the same plan; but a difference in appearance is caused by the inequality of the thickening of the primitive elements.

Antherozooids of Hepaticæ.†—M. Leclerc du Sablon has investigated the development of the antherozooids of Hepaticæ in *Metzgeria furcata*, *Radula complanata*, *Frullania dilatata*, and *Alicularia scalaris*. They are formed at once from the nucleus and from the protoplasm of the mother-cell. The body of the antherozooid does not correspond solely to the nucleus of the mother-cell, but to nucleus plus protoplasm. There is a change in properties and structure. The body of the antherozooid is more refractive and more homogeneous than the protoplasm of the nucleus, and is less susceptible to staining, especially at the climax of its formation. The mother-cell undergoes a total renovation in forming the antherozooid.

Characeæ.

American Characeæ.‡—The first part of Dr. T. F. Allen's monograph of American Characeæ is occupied by an Introduction, Morphology, and Classification. A complete account is given of the structure and development of the various organs, vegetative and reproductive, illustrated by very numerous and well-executed woodcuts. For the female organ before fertilization the term "sporophydium" is proposed, its cellular envelope being termed the "sporostegium." A clavis follows of all the American species belonging to the genera *Nitella* (79), *Tolypella* (13), *Lychnothamnus* (3), and *Chara* (62). *Lamprothamnus* does not occur in America.

With regard to the species described as *Tolypella Macounii*,§ Dr. Allen now ‖ regards it as a *Nitella*.

Algæ.

Attachment-organ of Algæ.¶—Dr. H. F. G. Stroemfelt calls attention to the different modes of structure and development of the basal portion of the thallus of algæ, by which they attach themselves to a sub-

* Rev. Bryol., xv. (1888) pp. 6–12. Cf. this Journal, *ante*, p. 263.

† Comptes Rendus, cvi. (1888) pp. 876–8.

‡ Allen, Dr. T. F., 'The Characeæ of America,' Pt. 1, 64 pp. and 55 figs., New York, 1888.

§ See this Journal, *ante*, p. 90. ‖ Bot. Gazette, xv. (1888) p. 11.

¶ Naturv. Studentsällsk. Upsala, May 13, 1887. See Bot. Centralbl., xxxiii. (1888) pp. 381 and 395.

stratum, and which is wanting only in unicellular and endophytic algæ. The attachment is always superficial, the organ having no function in the absorption of food-material similar to that of the root of higher plants. Three types may be distinguished of this organ, viz.:—

(1) On germinating, a single primary radicular cell is developed, which primary cell may either be the sole root-organ, or may develope secondary root-organs. The former case occurs only with comparatively few algæ; the simplest case is *Erythrotrichia*, which is attached only by its slightly differentiated basal cell; a somewhat higher degree of development occurs in *Œdogonium* and *Spirogyra adnata*, and a still higher in some species of *Cladophora* and *Chætomorpha*, e. g. *C. ærea*. In most cases there are also secondary radicular filaments, formed by a swelling at the basal end of a cell which developes into a filament, the growth of which is generally directed downwards. This filament may consist of one or more cells, and may branch; it may or may not be separated from the parent-cell by a septum. Various special cases of further development are described, such as the investing cortical filaments of *Batrachospermum*. The large attachment-disc of Fucaceæ is formed entirely of intercellular root-filaments.

(2) A creeping branched filament of cells is developed on germination. This usually branches into a layer, from which ascending axes rise which form the most conspicuous part of the alga; this may either remain distinct, or may coalesce into a cushion or crust, as in *Myrionema*, *Ralfsia*, *Lithoderma*, &c. It is not improbable that all the Phæozoosporeæ belong to this type; but in *Laminaria* it undergoes so many changes in the course of development as to be hardly recognizable. *Sphacelaria* is distinguished by its erect polysiphonous shoots.

(3) A cushion-like mass of cells is developed on germination. The algæ belonging to this type are all Florideæ with distinct thalloid shoots, such as *Furcellaria*, *Plocamium*, *Gigartina*, *Chondrus*, *Lomentaria*, &c. The organ does not here develope radicular filaments, as in the two preceding types.

Physiology of Phæophyceæ.*—Mr. T. Hick has chiefly investigated *Fucus vesiculosus*, *F. serratus*, *F. canaliculatus*, *Ascophyllum nodosum*, *Laminaria digitata*, and *Himanthalia lorea*. He has found that the cell-walls possess chemical and physical properties not met with in those of ordinary plants, and he concludes that these properties enable the walls to act as a reservoir of water, on which the tissues may draw when the plants are exposed to desiccating influences. The quantity of water contained by the wall may be very great; a piece of *A. nodosum* which, when dried, weighed 0·65 gramme, absorbed artificial sea-water until the weight reached 1·56 gramme, or a gain of 140 per cent.; in other experiments gains of from 200 to 240 per cent. were observed. The absence of stomata and intercellular spaces is usually correlated with the aquatic habit and consequent non-transpiration; it is to be remembered, however, that in aquatic phanerogams there is no well-developed system of intercellular spaces, and the absence in this particular case ought perhaps to be rather correlated with the absence of any necessity for mechanical assistance in maintaining the erect position, and may prevent transpiration when the plants are exposed; in any case it proves that intercellular spaces are not indispensable for respiratory

* Rep. Brit. Assoc. Adv. Sci., 1887 (1888) pp. 761–3.

purposes, and that in the plants studied the absorption of gases is performed by the superficial cells alone. Experiment proved that there is little or no movement of water from below upwards.

A number of brown seaweeds were examined without the presence of starch being detected in any one of them; proteids, on the other hand, are present in considerable quantities; the presence of the phycophæin which distinguishes the assimilating organs of the Fucaceæ from those of ordinary green plants may be directly or indirectly responsible for their peculiar action. With the presence of a large quantity of proteid material we may correlate the sieve-tube-like character of the rows of component cells.

Chemico-physiological Study of Algæ.* — Herren O. Loew and T. Bokorny state that algæ (Zygnemaceæ), superficially dried with blotting-paper, contain 85–90 per cent. of water; when dried at 100° their composition is—oil 6–9 per cent., albumin 28–32 per cent., cellulose and starch 60–66 per cent. The oil is situated chiefly in the chlorophyll region, but is not visible in drops under ordinary circumstances; lecithin is probably present. The quantity of starch varies very considerably according to circumstances; during conjugation its amount decreases, and glucose is formed. The gum is situated in the cell-wall, the tannin, however, in the substance of the plant. Cholesterin and succinic acid (0·4 per cent.) are also found in algæ, but the xanthines, leucine, and asparagine are not present. The authors conclude that Baeyer's theory of the formation of starch is the correct one, not only from the result of their own experiments, but because it is supported by other facts, especially by the rapid growth of bacteria in solutions containing compounds of methyl.

Crystalloids in Marine Algæ.†—Herr J. H. Wakker has examined the crystalloids in certain Florideæ, *Gracilaria dura*, *Dasya Wurdemanni*, and *Bornetia secundiflora*; also in *Vidalia volubilis*, *Derbesia Lamourouxii*, and four species of *Codium*.

They are all unchanged by alcohol and water, with the exception of those of *Vidalia*, which are dissolved in both these media; they swell up and subsequently disappear in dilute sulphuric acid or potash-lye. The author was unable to find any crystalloids in living plants of *Dasycladus*, *Acetabularia*, and *Bryopsis*.

The crystalloids in *Laurencia*, *Sphærococcus*, *Rhizophyllis*, and *Plocamium* are nearly globular strongly refringent bodies. Those of *Laurencia* are gradually made granular by distilled water, alcohol, and dilute potash-lye; under the influence of concentrated sulphuric acid they shrivel up, and exude small oily drops, in consequence of which the author includes them under the category of "elaioplasts."

Incrustation of the Cell-wall of Acetabularia.‡ — According to Dr. H. Leitgeb, the incrustation of *Acetabularia* does not consist, as has been usually supposed, entirely of calcium carbonate, but partly also of calcium oxalate in a crystalline condition. This latter salt is found chiefly in the inner layers of the cell-wall; and is formed earlier than the calcium carbonate. The sphæro-crystals of *Acetabularia* have been

* Journ. Prakt. Chem., xxxvi. pp. 272–91. See Journ. Chem. Soc. Lond., 1888, Abstr., p. 315.

† Nederl. kruidk. Arch., iv. (1887) pp. 369–82.

‡ SB. K. Akad. Wiss. Wien, xcvi. (1888) pp. 13–37.

determined by Leitgeb to consist of inulin; in the alcohol-material are found bright red partially crystalline masses, which correspond in many of their reactions to rhodospermin, but whose separation is the result of the action of the reagent. The cell-wall does not always consist of three distinct layers, as has been stated by Nägeli; the innermost is often wanting, and is then replaced by a thin parietal layer of protoplasm. The younger portion of the stalk, and the rays of the "pileus" are often furnished with a well-developed cuticle.

Batrachospermum, Chantransia, and Lemanea.*—Dr. A. Peter confirms the observations of Sirodot, that young plants of *Batrachospermum* may develope from heteromorphic branches of *Chantransia*. In addition to organs previously known, he has observed on *Chantransia* vesicular structures resulting from the swelling out of an ordinary filament-cell, the interior of which is ultimately divided into compartments. Whether these are organs of reproduction, or reservoirs of food-material, the author was unable to determine. He frequently observed the unbroken connection of the "prothallium" of *Chantransia* and *Batrachospermum*.

Dr. Peter also asserts the development of the sexual form of *Lemanea fluviatilis* out of heteromorphic branches of a *Chantransia*. The forms included in the genus *Chantransia* must therefore be regarded as stages of development in the life-history of a number of the higher Algæ.

Rejuvenescence of Caulerpa.†—Herr J. H. Wakker finds that in *Caulerpa* the rejuvenescence of the thallus after injury takes place in just the same way as in *Saprolegnia*, *Mucor*, *Vaucheria*, and in other Siphoneæ. The wound is first closed by a drop of protoplasm, after which a new cellulose-membrane is formed. The process is the same in these unicellular plants as in the formation of adventitious organs on the leaves of *Begonia* and of Crassulaceæ, and in bulbous plants. Prolification was never observed on cut leaves.

Dasycladaceæ.‡—Prof. C. Cramer describes a new species of *Neomeris*, *N. Kelleri*, from Madagascar. It has the form of small curved cylindrical bodies, from 5 to 14 mm. in height, and 1–2 mm. in thickness, brittle from a strong calcareous incrustation, pale green where not so encrusted, and furnished at the apex with a tuft of hairs. The surface consists of a large number of usually hexagonal facets, to near the upper margin of each of which is attached a long delicate simple or branched hair; these hairs drop off from the lower portion of the plant, leaving scarcely any visible scar. The axis of the plant is occupied by a very large nearly cylindrical fusiform cell, which ends below in a branched unseptated radicular portion. From the axial cell proceed a large number (from 60 to 80) of lateral branches, which are separated from the axial cylinder by a septum; and these are again furnished with secondary branches, usually three to each primary branch. The hairs are also not in direct connection with the main axis, and may themselves each consist of from two to five very elongated cells. Of the three secondary branches attached to each primary branch, the central one is ovoid and communicates by a narrow opening with the primary branch;

* Bot. Ver. München, Feb. 28, 1887. See Bot. Centralbl., xxxiii. (1888) p. 188.
† Versl. K. Akad. Wetensch. Amsterdam, iii. (1887) pp. 251–64 (1 pl.).
‡ Denkschr. Schweiz. Naturf. Gesell., xxx. (1887) 50 pp. and 5 pls.

while the two lateral branches are shut off by septa, are club-shaped, their apices form the superficial hexagonal facets, and each ends in a hair. All the cell-walls are strongly doubly refractive. The axial cell possesses a distinct power of apical growth. The order of formation of the branches is acropetal. No nucleus or crystalloids could be detected.

The author then gives descriptions of other allied species and genera, viz. *Neomeris dumetosa* Lmx., *Dasycladus* Ag., *Cymopolia barbata* Lmx., *Acetabularia* Lmx., and *Polyphysa* Lmx.

Dr. Cramer proposes to include the above genera under the family Dasycladaceæ, in which the primary axial cell is prolonged below into rhizoids not separated by septa; axial cell always sterile, lateral branches fertile. These short branches are sporangia, which may either produce directly gametes, i. e. conjugating swarm-cells, or spores, within which the gametes are produced. The zygotes resulting from the conjugation of the gametes may give rise either to sexual or to spore-producing individuals, exhibiting, in the latter case, an alternation of generations. The family may be divided into two sub-families, the *Acetabularieæ* and the *Dasycladeæ*. In the former are included the following genera:—(1) *Polyphysa* (*P. peniculus* and *Cliftoni*); all the fertile branches free to the base, forming a single whorl at the end of the erect stem; gametes unknown; only known mode of reproduction by spores. (2) *Acetabularia* (*A. mediterranea*, *crenulata*, and *Calyculus*); all the lateral branches completely united laterally into an umbrella-shaped structure; reproduction by conjugation of gametes. To the Dasycladeæ belong:—(3) *Dasycladus* (*D. clavæformis*, *australasicus*, and *occidentalis*); club-shaped spongy plants; axial cell usually simple and torulose; lateral branches branched; all thick-walled; reproduction uncertain. (4) *Neomeris* (*N. Kelleri* and *capitata*); axial cell always simple; lateral branches consisting of a fertile secondary branch (sporangium), and usually two greatly elongated sterile secondary branches; no production of gametes known. (5) *Cymopolia* (*C. barbata*); axial cell segmented and dichotomizing repeatedly in one plane; secondary branches in whorls, and the upper whorls repeatedly branched; reproduction unknown.

New Genera of Phæozoosporeæ.*—Herr H. F. G. Stroemfelt describes two new genera of Phæozoosporeæ from the coasts of Norway:—

Microcoryne n. gen. Chordariacearum. Frons ex axi centrali hyalino et filis peripheriçis endochromate largiore præditis, pilis hyalinis intermixtis, composita. Gametangia transformatione filorum peripheriçorum orta, elongata, subcylindrico-fusiformia, unam tantum seriem loculorum continentia. *M. ocellata* on *Chorda filum*.

Phycocœlis n. gen. Ectocarpacearum. Frons e strato basili filis repentibus formato et filis erectis inde exeuntibus, pilis hyalinis intermixtis constituta. Gametangia transformatione filorum erectorum orta, unam tantum seriem loculorum continentia. *P. fecunda* on *Rhodymenia palmata*.

Ulothrix.†—M. F. Gay has followed the history of development of several aerial species of *Ulothrix*, and has come, on some points, to different conclusions from those of Hansgirg.‡ The species specially ex-

* Notarisia, iv. (1888) pp. 381–4 (1 pl.).
† Bull. Soc. Bot. France, xxxv. (1888) pp. 65–75.
‡ See this Journal, 1885, p. 1037.

amined are *U. radicans, parietina*, and *crenulata*, all of which he considers ought properly to be placed under *Schizogonium*. In *U. radicans* the chloroleucites appear completely to fill up the cell-cavity, and do not constitute a parietal plate, as in true species of *Ulothrix*. They have the form of irregular stars, characteristic of *Prasiola* and *Schizogonium*, and similar to that in *Zygnema*. The filament usually consists of a single row of cells, less often of several, but never takes the true ribbon-like form of *Prasiola*. It differs moreover from *P. crispa* in the presence of rhizoids; and the author believes that its identification as a form of development of that alga is founded on a mistake. *U. parietina* W. & N. he identifies with *Schizogonium* Rabh. The author also disputes the identity asserted by some writers between *Ulothrix* and *Pleurococcus*.

Schizogonium is characterized by a filamentous or ribbon-shaped thallus, consisting in the latter case of two collateral rows of cells, rarely a larger number, and formed by longitudinal septation of the filament. *Prasiola*, on the other hand, has a foliaceous thallus, derived directly and by various processes from reproductive cells or propagula. *P. crispa* partakes of the characters of both genera.

New Species of Biddulphia from Fiji.—Mr. F. Kitton writes that in a gathering made at Vuna Point, Island of Taviuna, Fiji, by Mr. H. B. Brady (which he placed at Mr. Kitton's disposal), he has found a new species of *Biddulphia* in considerable abundance, and which he describes as follows:—

Biddulphia echinata n. sp. F. K. Frustule quadrangular, cingulum punctate, valves broadly elliptical or suborbicular, very convex, processes conspicuous, divergent, with a few short spines at the base, margin distinctly spinous, upper surface more or less covered with triangular scales (spines?) attached by one of the sides, inner surface finely punctate, length from 0·0032 to 0·0085 in., breadth 0·0025 to 0·0075 in.

Mr. Kitton remarks that this species seems to be very subject to abnormal development; he has seen it circular with three equidistant processes, triangular ditto, oblong with two imperfectly developed processes at one end, and a perfect one at the other.

Fossil Diatoms of Hungary.*—Dr. J. Pantocsek publishes the first part of an illustrated work on the fossil diatoms of Hungary, which comprises fossil forms from the Tertiary strata. They include a number of remarkable forms, the genus *Trinacria* being largely represented. The species included in this part are all marine, and furnish evidence of the existence during the Tertiary period of a tropical ocean, bounded by the chain of the Carpathians, the mountains of Bitraria, and the Balkans.

Lichenes.

Culture of Lichen-forming Ascomycetes without Algæ.†—Herr A. Möller has repeated the experiments of Brefeld and others on the nature of the so-called "spermatia" of lichens, and has come to the same conclusion that the earlier view which regarded them as male reproductive organs is erroneous. He was able, in a number of cases, to induce germination of these "spermatia," with the production of a mycelium,

* Pantocsek, Dr. J., 'Beitr. z. Kenntniss d. fossilen Bacillarien Ungarns,' Th. 1. See Journ. de Micrographie, xi. (1887) p. 484.

† Unters. Bot. Inst. K. Akad. München, 1887, 52 pp.

and ultimately even of a thallus. This thallus was then indistinguishable from that of an ascosporous fungus, and developed new "spermogonia," the "spermatia" from which germinated in the same way. It follows that these organs are of the nature of conidia, and the author therefore substitutes for the terms "spermogonia" and "spermatia," *pycnidia* and *pycnogonidia*.

Successful experiments in germination were made in fruticose, foliaceous, crustaceous, and gelatinous lichens. Details only are given of those on crustaceous lichens, including the species *Lecanora subfusca*, *Thelotrema lepadinum*, *Pertusaria communis*, *Buellia punctiformis*, *Lecidella enteroleuca*, *Opegrapha subsiderella*, *Graphis scripta*, *Arthonia vulgaris*, *Calicium parietinum*, *C. trachelinum*, *Verrucaria muralis*.

The author concludes by saying that all "spermatia" of lichens, whether belonging to fruticose, foliaceous, or gelatinous forms, are formed, like those here described, either on simple sterigmata or on arthrosterigmata, within the chambers designated "spermogonia," and there cannot be the slightest doubt about the perfect morphological identity of all these organs.

Fungi.

Sterility of Fungi.*—Herr P. Magnus describes a number of instances in which fungi have lost their power of producing spores, and have developed also in a monstrous fashion, from the absence of light. The same result follows from a deficient supply of nutriment. The author adduces a remarkable case of the development in mushroom-culture in Berlin, as the result of overmanuring, of bodies having a general external resemblance to sclerotia, but resembling in structure the receptacles of subterranean Gasteromycetes, in which the formation of the gleba has been suppressed.

Classification of the Agaricineæ.†—M. N. Patouillard considers that the small degree of constancy in the vegetative characters of the Agaricineæ renders their classification difficult. The coloration of the spores is a very important character, and the distribution of the genera in series having spores of the same colour is useful for study; but this arrangement is far from corresponding to their natural affinities. As in all systems of classification where the essential character is not sufficiently dominant, one finds in certain genera species, or even groups of species, which have only one single character in common with others of the same genus. This common character ought to be made of primary importance in some cases, but of secondary value in others.

The author then gives numerous examples. In comparing *Lepiota* with *Coprinus*, two genera which have many characters in common, the former, however, having white spores and the latter belonging to the Melanosporeæ, it will be observed that in the genus *Lepiota* there are several species which, besides their own generic characters, have others common to the two groups. This analogy has been long recognized, and several of the *Lepiotæ* are designated as having a *coprinoid facies*. From the instances quoted in the paper, the author states that it will be seen that the character of the colour of the spores ought not to be made the pivot

* Versamml. Deutsch. Naturf. u. Aerzte, Wiesbaden, Sept. 21, 1887. See Bot. Centralbl., xxxiii. (1888) p. 62.

† Morot's Journ. de Bot., ii. (1888) pp. 12–6.

for the division of the Agaricineæ, but only retained as a generic character.

Identity of Polyporus abietinus Fr. and Irpex fusco-violaceus Fr.* —M. L. Morot had the good fortune to find in the forest of Sénart numerous specimens of *Polyporus abietinus* Fr. and *Irpex fusco-violaceus* Fr., and was able to observe the passage of the one into the other, and thus establish their identity. The author states that certain other members belonging to the genera *Irpex*, *Sistotrema*, and *Dædalea* seem destined to disappear, and to belong really either to *Polyporus* or *Lenzites*.

Polymorphism of the Hyphomycetes.†—Sig. G. Gasperini has made a series of experiments on the cultivation of various fungi which he classes among the Hyphomycetes, with special regard to the effects on the course of development of changes in the temperature, the degree of moisture, the nature of the substratum and environment, &c. The genera chiefly experimented on were *Verticillium*, *Penicillium*, *Aspergillus*, and *Sterigmatocystis*; and the following are the more important conclusions at which he arrived.

(1) The degree of autonomy of the species of Micromycetes investigated does not differ fundamentally from that ascribed by modern biologists to the higher organisms; in no instance were sporophores truly typical of distinct species or genera found to spring from the same mycelial filament either simultaneously or successively.

(2) All the species followed out in their natural evolution from the spore to the adult plant, and to the sporigenous condition, present a cycle of forms constant in proportion as the conditions of the experiment were unchanged.

(3) Species cultivated in a moist chamber with suitable substratum, at the ordinary atmospheric pressure, and with abundant oxygenation, exhibited peculiarities which were less marked in their natural state, or of which they were altogether deficient, peculiarities which have given rise to not a few errors in taxonomy.

(4) Species growing in conditions unfavourable to their development exhibit a distinct tendency to assume lower forms:—an example of atavism or reversion to a primitive type.

(5) The proportion between the luxuriance of the mycelium and the number and complexity of structure of the sporophores, varies in each species within wide limits.

(6) The polymorphism of the conidial fructification, in the various species examined in diverse vital conditions, remained constantly within limits marked on one side by the typical form, on the other side by fertile hyphæ differing from the mycelial filaments, with which they were continuous only in bearing one or more conidia at their extremity. Between these extremes each species presented a complete gradation of forms.

(7) The fasciculate varieties of *Penicillium*, known as *Coremium* and *Coremioides*, formerly considered to be accidental, or dependent on an abundant supply of food-material, express rather a biological adaptation, special and unfavourable to vital conditions, for the purpose of providing for the perpetuation of the species.

* Morot's Journ. de Bot., ii. (1888) pp. 30–2.
† Atti Soc. Tosc. Sci. Nat., vi. (1887) pp. 20–6.

(8) The varieties *Coremium* and *Coremioides*, which occur not only in *Penicillium*, but also in *Verticillium* and *Aspergillus*, become more persistent by the aggregation of fertile filaments, until the spores of a *Coremium* reproduce the same form even in conditions in which at first it would not have been produced.

(9) The purpose of the Hyphomycetes in the economy of nature appears to be to prepare dead or dying organic substances for the attack of the Schizomycetes by which their putrefaction is accomplished.

(10) If species of Hyphomycetes are transplanted singly into an Erlenmeyer's chamber containing a sterilized substratum, and are then infected by *Micrococcus prodigiosus*, they do not appear to experience any evil effects in their development, but in time cover the whole surface of the culture, and exhibit well-developed sporophores.

Cultivation of Phycomycetes.*—Herr W. Zopf recommends the following method for the cultivation of Chytridiaceæ, Saprolegnieæ, and Monadineæ. He covers the surface of the water with pollen-grains (those of Coniferæ are best), or spores of ferns or fungi. The zoospores of the Phycomycetes attack these and develope in them, and their growth can be readily watched. He has followed in this way the development of *Rhizophidium pollinis*, and of four new species, *Lagenidium pygmæum*, *Rhizophidium Sphærotheca*, *R. Cyclotellæ*, and *Rhizophyton Sciadii*.

Herr Zopf finds *Rhizophidium pollinis* to be not epiphytic, but parasitic, with an endophytic mycelium. Besides the well-known zoospores, he finds large resting-spores. The escape of the zoospores takes place through several openings. It attacks the pollen-grains of many Angiosperms and Gymnosperms.

Rhizophyton Sciadii attacks the cells of *Sciadium arbuscula*. Its zoospores attach themselves, and put out a branched mycelium into the cell-cavity of the host, forming zoosporangia externally which open by an apical pore. No resting-spores were observed.

Rhizophidium Sphærotheca was observed on the microspores of species of *Isoetes;* the course of development resembles that of *R. pollinis*, but the zoospores are smaller. Resting-spores were not observed. *R. Cyclotellæ* does not attack pollen-grains, but is a parasite on *Cyclotella*. The zoospores are very minute, from 1·8 to 2·5 μ; the sporangia open by from 1 to 3 orifices.

Lagenidium pygmæum was found on pollen-grains of *Pinus Laricio* and allied species. The mycelium developes in the interior of the pollen-grain and puts out a perforating tube, which often branches and then developes into a globular zoosporangium. The zoospores are biciliated. The mycelium of the sexual generation is stouter, and soon divides into an antheridial and an oogonial cell. The latter rounds itself off, while the former puts out a conjunction-tube which penetrates the oogonium; and the oospore results from the passage of the whole contents of the antheridium.

Pleospora.†—Dr. A. N. Berlese gives a monograph of this genus of Sphæriaceæ, of which he makes 105 species, reducing to the condition of synonyms a very large number of published species. He divides the genus into 7 sections, as follows, viz.:—A. Sporidia transverse triseptata, loculis uno alterove septis longitudinaliter divisis; B. Sporidia trans-

* Abhandl. Naturf. Gesell. Halle, xvii. (1887) (2 pls.). See Bot. Centralbl., xxxiii. (1888) p. 325. † Nuov. Giorn. Bot. Ital., xx. (1888) pp. 1-176 (8 pls.).

verse 4-septata loculis uno vel duobus septis longitudinaliter divisis; C. Sporidia transverse 3–5-septata; D. Sporidia transverse semper 5-septata; E. Sporidia transverse 6–7-septata; F. Sporidia transverse 8-pluri septata; G. Sporidia hyalina.

Trichosphæria paradoxa and Herpotrichia nigra.*—Herr R. Hartig gives some further particulars respecting these two parasitic fungi parasitic on Conifers.

Trichosphæria paradoxa attacks almost exclusively *Abies pectinata*. The pseudoparenchymatous mycelium puts out a number of rod-like haustoria, which penetrate the cuticle, but do not actually enter the epidermal cell. These haustoria exude a ferment which kills the adjacent mesophyll-cells; and a number of hyphæ then enter the leaf through the stomata, completely killing it. The ripe spores are usually divided into four, sometimes into only two or three compartments, or are rarely undivided.

Herpotrichia nigra is parasitic on *Picea excelsa*, *Pinus montana*, and *Juniperus communis* and *nana*. The dark-brown granular mycelium also puts out haustoria into the cuticle. The asci are large, 76–100 μ long and 12 μ wide; they contain eight ascospores, each of which is constricted and septated in the middle.

Taphrina.†—Herr C. J. Johanson has made a careful study of the twenty-one species of *Taphrina* Fr. (*Exoascus* Fkl.) known in Sweden, five of which have not been found outside the Scandinavian peninsula. The character hitherto considered common to the genus, of producing a hibernating mycelium, he finds to be not universal; an exception is furnished by *T. carnea;* and probably also by *T. Sadebeckii*, parasitic on the leaves of *Alnus glutinosa*, and by *T. Betulæ*.

The following new species are described:—*T. alpina*, and *T. bacteriosperma* on living leaves and branches of *Betula nana*. The former of these species produces the deformation known as "witch-broom," while the latter does not. The latter is the only species which extends into Greenland. *T. rhizophora* Johans. (*Exoascus aureus* Sad.) is distinguished by the absence of pedicel-cells, and by the asci having yellow contents, and putting out a long narrow root-like portion into the tissue of the host. It occurs on the fruit of *Populus alba* and *tremula*, causing them to become deformed and covered by a yellow bloom.

Character of the Injuries produced by Parasitic Fungi upon their Host-plants.‡—Mr. A. B. Seymour discusses the various ways in which parasitic fungi injure their host-plants.

Firstly, they deprive them of nourishment; this is by far the most important and general injury which is produced upon plants by parasitic fungi. (2) While the food supply of the plant is reduced, its power to replenish it is at the same time impaired, i. e. in case the fungus grows upon the green parts, as it does most frequently. (3) Growth may be abnormally accelerated or retarded, and both these effects may be produced in different cases by the same fungus, thus causing distortion; (4) not only green parts are affected, but roots, stems, inflorescence, flowers, and fruit; (5) leaves and fruit when diseased fall prematurely.

* Hedwigia, xxvii. (1888) pp. 12–5. Cf. this Journal, 1886, p. 298.

† Naturv. Studentsällsk. Upsala, April 28, 1887. See Bot. Centralbl, xxxiii. (1888) pp. 222 *et seq.* Cf. this Journal, *ante*, p. 274.

‡ Amer. Naturalist, xxi. (1887) pp. 1114–7.

(6) Many fungi cause decay of ripe fruit, both while attached to the plant and after removal while still alive. (7) Some valuable plants are liable to injury from others of less value by ordinary infection or heterœcism.

Certain groups of phanerogams are liable to be attacked by certain groups of fungi.

New Disease of the Douglas-pine.*—Dr. C. v. Tubeuf describes a disease which is very destructive to *Pseudotsuga Douglasii*, produced by the attacks of the mycelium of an (unidentified) parasitic fungus. It causes the branches to curve and the leaves to fall; the mycelium puts out processes which appear as black spots on the leaves. Late in the year sclerotia are formed which gradually burst the epidermis. From both the sclerotia and the mycelium there arise conidiophores resembling those of *Botrytis*. The conidia germinate in water and nutrient solutions, putting out from one to three germinating tubes which develope into septate mycelial filaments which subsequently become green.

New Potato-disease.†—Herr J. Brunchorst describes a potato-disease known under the name of "scurf," caused by the attacks of an undescribed species of Myxomycetes, to which he gives the name *Spongospora Solani*.

New Vine-disease.—Dr. F. v. Thümen ‡ describes a new disease of the vine in south Tyrol which destroys the immature berries, and which he states is caused by a hitherto undescribed parasitic fungus, *Acladium interaneum*.

Herr E. Ráthay asserts § that the fungus described under this name is identical with *Peronospora viticola*, and that the bodies which v. Thümen calls its conidiospores are in reality the haustoria of the *Peronospora*.

New Parasite of the Silk-worm.‖—Prof. R. Moniez publishes a brief notice of a new parasite which he found in great abundance in the visceral cavity of diseased silkworms. The liquid of the cavity was milky, and this was due to the extraordinary abundance of small (3 μ in diam.) spherical homogeneous elements, in which no trace of nucleus could be seen. Other bodies both larger and smaller were observed. There were hints that reproduction took place by regular segmentation; but no fission nor budding was to be seen. It seemed probable that the multiplication of the fungus took place within the tissues and not in the visceral cavity.

There was no possibility of confusing this parasite with that of pebrine, and still less with that of muscardine. It differs from the former in size, form, constant absence of the clear spot, and of fission. The elements observed were in size and form like the spores of the muscardine fungus, but form asci, and do not exhibit cylindrical conidia or filamentous mycelia. The symptoms of the disease are furthermore different from those either of pebrine or muscardine.

* Bot. Ver. München, March 21, 1887. See Bot. Centralbl., xxxiii. (1888) p. 347.
† Bergens Museums Aarsberet., 1887, pp. 219–46 (2 pls.).
‡ Weinlaube, 1886, pp. 447–8. See Bot. Centralbl., xxxiii. (1888) p. 16.
§ Id., 1887, 37 pp., 2 pls., and 10 figs. See id., p. 17.
‖ Bull. Soc. Zool. France, xii. (1888) pp. 535–6.

Protophyta.

Filamentous Heterocystous Nostochineæ.*—Messrs. E. Bornet and C. Flahault have prepared a synoptical table to all known species of Rivulariaceæ, Sirosiphonaceæ, and Scytonemeæ. These include 21 genera and 114 species. Of these species 83 are fresh-water, and 27 marine, while 4 belong to brackish water. 20 of them are cosmopolitan; 52 belong to Europe only, 40 to America, and 5 to the East; 18 are common to Europe and America, 6 to America and the East, 2 to Europe and the East. In temperate countries, and especially in Europe, the plants of these families abound most in the warmer regions; and the reason why so comparatively few species are known to inhabit the tropics is probably the paucity of material from those countries. Advancing from the hot level country to the mountains, the species gradually become less numerous, and finally disappear altogether in the Alpine regions. The fourth family or Nostocaceæ are not treated of in this paper.

New Chromogenic Bacillus—Bacillus cœruleus.†—Dr. J. A. Smith has found in the water of the Schuylkill river a hitherto unknown species of chromogenic bacillus, which he has named *Bacillus cœruleus*. At ordinary temperatures it developes on boiled potato a beautiful dark blue colour, which later deepens to a black-blue. The colonies form cup-shaped depressions with raised edges. It is aerobic, at least its colour-formation is associated with access of air, for cultivations within the gelatin mass are colourless, while the upper part shows a bluish tinge. Gelatin cultivations were always fluid on the surface. The cells take up the colour, which is insoluble in water, spirit, or acid. On potato, where the colour is best seen, the bacilli, in contrast to *Micrococcus cyaneus*, only grow on the surface. The bacillus is 2–2·5 μ long and 0·5 μ broad. It usually developes in leptothrix-like chains. If the preparations were overheated, many became comma-shaped. They stain well with methyl-violet.

Bacillus cœruleus is distinguished from *B. syncyaneus*, *B. violaceus*, and *M. cyaneus* by its deep blue colour. It is not pathogenic.

Scheurlen's Cancer Bacillus.‡—Prof. P. Baumgarten, in conjunction with Dr. Rosenthal, immediately after the publication of Scheurlen's communication on the cancer bacillus, instituted a series of experiments for ascertaining the value to be attached to the presence of the organism in question. He states that before the cultivation experiments with cancer juice were begun, there presented itself as an unbidden guest upon a potato slice a bacillus, which in its appearance and morphology bore a striking likeness to Scheurlen's bacillus, even if it were not identical therewith. The only demonstrable difference between the two consisted in the fact that the rod-like cells and spores of the potato bacillus seemed somewhat larger than the corresponding formations from the Scheurlen preparations, and that the potato bacillus fluidified the gelatin more strongly than was the case with Scheurlen's cancer bacillus. By means of Scheurlen's method he succeeded in obtaining from the juice of a large number of cancers, chiefly of the mamma, but also from various other

* Mem. Soc. Sci. Nat. Cherbourg, xxv. (1887) pp. 195–222. Cf. this Journal, 1887, p. 793.

† Med. News, 1887 (ii.) p. 758.

‡ Centralbl. f. Bakteriol. u. Parasitenk., iii. (1888) pp. 397–8.

places, a bacillus almost completely resembling the potato bacillus on the one hand, and Scheurlen's bacillus on the other. The same bacillus was also found in the juice of a sarcoma of the mamma, a sarcoma of the pericranium, and even in a neuroma of the vola manus. Moreover the Scheurlen cancer bacillus (or a bacillus extremely like it) does not merely appear in carcinomata, but in other neoplasms, and not only is it not exclusively associated with carcinoma, but it is found in agar plate cultivations in connection with various other kinds of bacteria derived from the cancer juice. Nor is the Scheurlen bacillus a constant concomitant of cancer, for the author failed to find it in a cancer of the rectum, and also in a case from the mamma, although submitted to the same procedure. The author therefore concludes that there is no proof that the Scheurlen bacillus is peculiar to cancer, and suspects that it is an immigrant from the skin or mucous membrane.

Spore-formation in the Bacillus of Glanders.*—Prof. P. Baumgarten states that Dr. Rosenthal has made numerous experiments to determine the question, previously unsolved, of endogenous spore-formation in glanders bacillus. Numerous experiments with cover-glass preparations from somewhat old potato cultivations of this microbe have shown the presence of spores, the appearances resembling those obtained with anthrax bacillus. Neisser's method for staining spores (one hour's staining in Ehrlich's fuchsin solution in a steam sterilizer at 100° C., or at 150° C. with dry heat, decolorizing in hydrochloric acid and alcohol, and after-staining with methylin-blue) was adopted. The spores were coloured a deep red, and the rest of the rodlet blue. The spores were for the most part free, but sometimes within the bacilli. It must therefore be considered as settled that glanders bacillus forms spores, but whether always or under certain conditions only remains to be determined.

Bacterio-purpurin.†—Dr. T. W. Engelmann, who in 1882 described a red bacterium, *B. photometricum*,‡ has recently examined this and other red Schizomycetes obtained both from fresh and salt water. The forms examined are known as *B. photometricum*, *roseo-persicinum*, *rubescens*, and *sulfuratum*, *Clathrocystis roseo-persicina*, *Monas Okeni*, *vinosa*, and *Warmingii*, *Ophidomonas sanguinea*, *Rhabdomonas rosea*, and *Spirillum violaceum*. Whether they are one or the same kind, they at any rate belong to the sulphur bacteria which, in the presence of free hydrosulphuric acid, become filled with sulphur granules and oxidize this sulphur to sulphuric acid. All are coloured by a purplish-red pigment diffusely disseminated in the protoplasm (bacterio-purpurin Ray Lankester).

The recent experiments have confirmed the earlier ones as to the behaviour of *B. photometricum* and the others to light, the peculiar influence of which is not associated with the presence or absence of sulphur, but with the presence of bacterio-purpurin, wherefore it is proposed to distinguish these forms of "Purpuro-bacteria" from the unpigmented sulphur-bacteria which are not influenced by light.

From a series of experiments made with sun, gas, and electric light, the spectra showed that there was an evident proportion between absorption and physiological effect, and that this, like the analogous chemical process of carbon assimilation by chlorophyll, was brought about by

* Centralbl. f. Bakteriol. u. Parasitenk., iii. (1888) p. 397.
† Arch. f. d. Gesammt. Physiol. (Pflüger), xlii. (1888) pp. 183–6.
‡ See this Journal, 1883, p. 256.

the action of light. The purple bacteria in fact give off oxygen under the influence of light, and culture-experiments showed that the development, growth, and multiplication of purple Schizomycetes is only permanently possible in the light.

The elimination of oxygen is intimately associated with the presence of bacterio-purpurin in the living protoplasm. Yet, as with chlorophyll, it stands in no simple relation to the saturation of the plasma with the pigment. In individual cases, however, it is proportionate for different wave-lengths to the absorbed energy of the light. Ultra-red (gas or sunlight deprived of visible rays by means of iodine in sulphide of carbon or pure ultra-red between 0·80 and 0·90 μ wave-lengths) acts less weakly than perfectly mixed light. The visible red, the extreme ultra-red, violet, and ultra-violet, gave, at least in the spectrum of powerful gas-light, no obvious effect.

Bacterio-purpurin is therefore a true chromophyll; apparently not a simple chemical body, but a mixture like other chromophylls (chlorophyll, diatomin, rhodophyll); and is distinguished from the latter most strikingly by the absence of the green constituent. It demonstrates anew that the elimination of oxygen can be effected in the light by non-green pigments and by every kind of wave-length, and that in all cases, for the different wave-lengths it is proportional to the absorbed energy of the light.

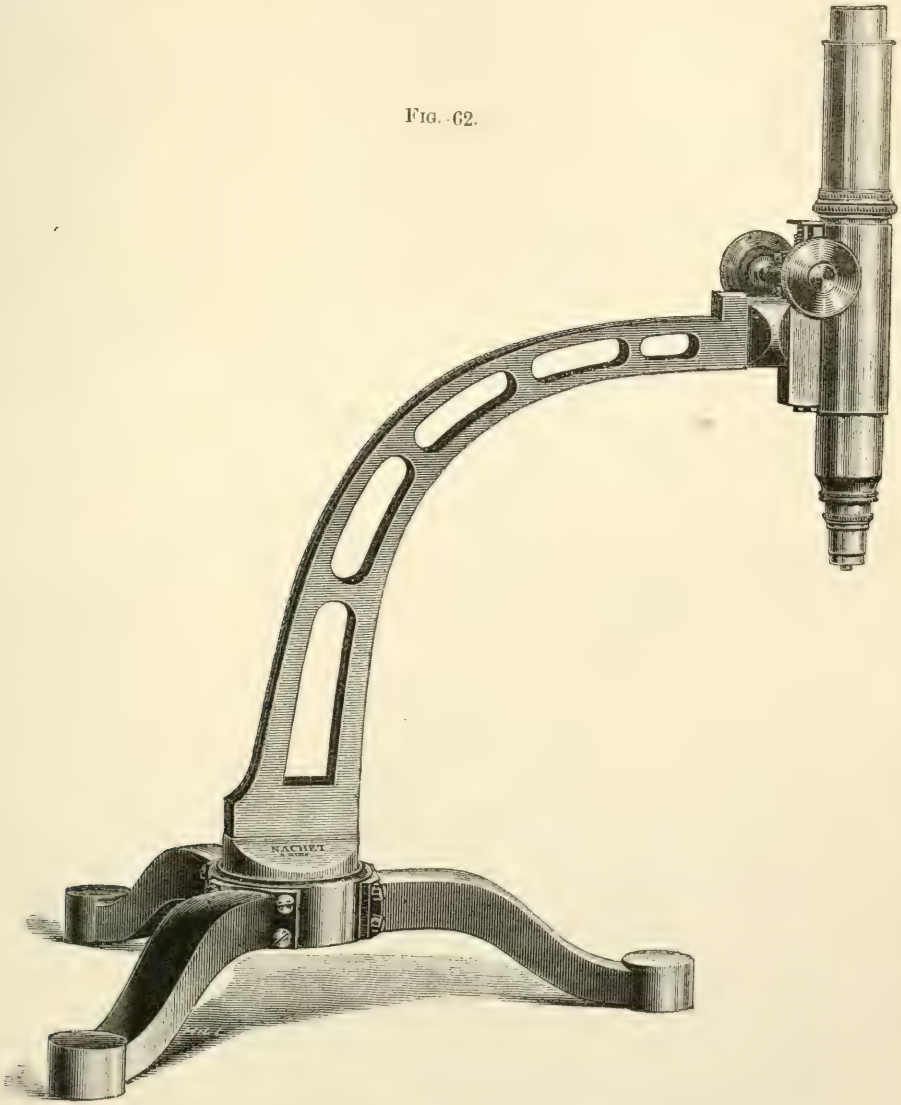
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Nachet's Crane-arm Microscope.—This form of Microscope (fig. 62) was designed by M. A. Nachet on the suggestion of Prof. Lacaze-

FIG. 62.



* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

Duthiers to meet the case of microscopic examination being required of the surfaces of large objects of various kinds, especially animals.

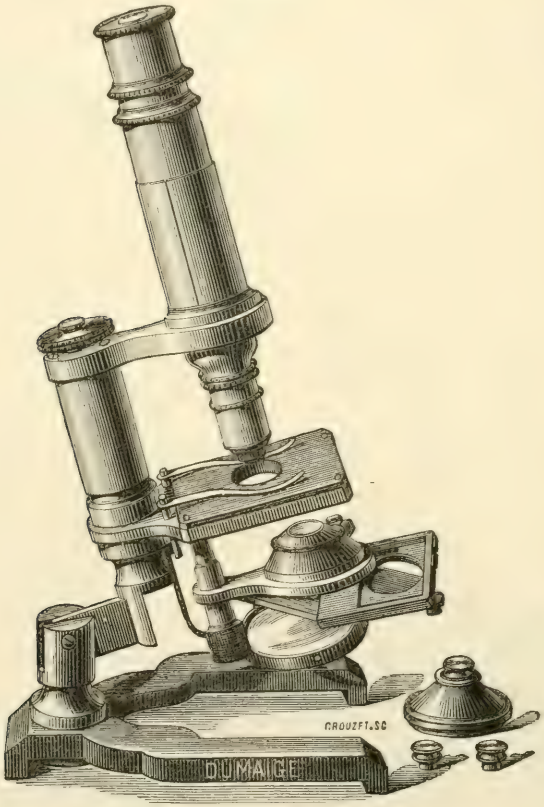
On a tripod with broadly spreading feet is fixed, so as to rotate on the centre of the tripod, a curved standard 20 inches long, pierced in five places to reduce the weight. At the top of the standard is the slide support for the body-tube, which is raised and lowered by rack and pinion. The slide itself also rotates laterally on the end of the standard so that the body-tube can be set at an angle.

Dumaige's Travelling Microscope.* — This Microscope of M. Dumaige (fig. 63) anticipates one of the features of Mr. Giles's "Army Medical Microscope," in that the stage and foot are in one piece.

The following is a translation of the description :—

"The instruments which the makers offer for sale under the name of travelling Microscopes, if they have the advantage of being small in size,

Fig. 63.



have on the other hand, in most cases at least, the grave inconvenience of being deficient in the stability necessary for delicate observations.

* Comptes Rendus Soc. de Biol. (Paris), 1887, p. 103. (Séance of 19th Feb.)

M. Dumaige has devised an instrument which while packing into a small compass, has all the conditions of perfect stability and all the improvements which are applied to large laboratory Microscopes.

When set up the instrument is an inclining Microscope of ordinary dimensions. It can be divided into two parts; the first comprising the stem and the tube; the second the stage and the foot.

The standard is fixed on the stage by a screw of special construction having four threads. This mode of construction assuring very great stability, it has been possible to make the standard very short. Owing to the arrangement of the screw it is sufficient to turn the standard half round to fix it in the stage perfectly securely.

The lower part of the Microscope can be reduced to minimum dimensions by [rotating the stage and short pillar 180° and then inverting the stage on the hinge by which it is connected with the pillar] and placing it between the feet of the base.

Thus divided and folded the Microscope occupies only a small space, and can be placed in a case of reduced dimensions" (6 in. × 6 in.).

A special condenser is added, differing, however, from the Abbe form only in its mechanical part, which is arranged so as to take up only a very small space.

Nelson's Mechanical Stage.—In bringing before the March meeting a new mechanical stage, Mr. E. M. Nelson said he "desired to point out that, in designing a Microscope, one had to guard against falling into one of two errors—over-complexity on the one hand, and over-simplicity on the other. It must be remembered that over-simplicity is an error just as great as over-complexity; it is to be feared that in consequence of so much notice having been given to over-complexity (and surely it was wanted), the other error of over-simplicity has been neglected. It is almost an abuse of terms to call the heavy-footed, non-inclining, Continental abomination, with its spring-clip stage, small aperture, and with a sliding-tube coarse-adjustment, by the now exalted name of Microscope. As to stages, it would be hard to invent a worse form than that usually found in Continental stands, consisting of a small flat stage, one small hole, and spring clips."

Mr. Nelson then described his new stage as follows:—

"The stage, which is of my horseshoe form, has two narrow vertical slots cut in it, one on either side of the opening. The usual rack-and-pinion which is placed underneath the stage, moves blocks sliding in the vertical slots. These blocks come flush with the stage, and have a screw in them, the head of which, projecting above the stage and pressing against the lower edge of the slide, pushes it up. The position of the Microscope is assumed to be an inclined one, then on turning back the pinion the slide drops. In fine, the slide is kept against the screw-heads by gravity, the Microscope being inclined.

As the blocks only come up through the slots flush with the stage, the screw-heads alone projecting, a plain stage may be obtained at any time by removing the screws. Or, if preferred, a bar may be fixed by the screws to the blocks, which will make a mechanical sliding bar.

This last is the form I have adopted in my own Microscope. In addition to the vertical, a horizontal movement may be fitted in the same way by slotting the stage and moving a block by a screw underneath. Such a fitting has been put to the Microscope before you. It is obvious that by such a method one can push the slide across the stage; but there

is no means but that of the finger to bring it back again. Of course, by keeping the slide pressed against the stud one can regulate the motion backwards by means of the screw. If a horizontal backward motion is required, there are two—and only two—alternatives before you: either you must clip the slide, or you must place the slide in a moving plate. If, on the one hand, the slide is clipped, you fall into the errors mentioned above; and if, on the other, you adopt the moving plate, you must, if it is to stand a crucial test, copy the Powell model. Now, as the scope of the new stage is to improve the student's Microscope at a small extra cost, it stands to reason that the second alternative is out of the question.

The advantages I claim for the new movement are as follows:—

(1) The vertical and horizontal movements are independent of one another, so you can have a vertical movement fitted to your Microscope without the horizontal, or *vice versâ*.

(2) By removing the screws in the blocks which are the only things above the stage, the stage is left perfectly plain, just as if there was no mechanical movement at all.

(3) By merely slotting the sliding-bar, to enable it to pass over the screw-heads, the sliding-bar and the mechanical movement can be used independently of one another.

(4) By screwing a bar to the blocks you have a perfect mechanical vertical movement. This, I think, in practice, will be found the most useful.

(5) By graduating the heads of the pinions, and by marking the stage for each complete revolution, a finder and a rough micrometer sufficiently accurate for low and medium powers is made.

(6) It is inexpensive.

(7) And perhaps the most important. The moving pinions being fastened to a fixed stage, and the blocks sliding in grooves in the stage, renders the movement peculiarly steady."

When exhibited it was pointed out * that as both hands are required to work the stage—one for the milled head and the other to keep the slide pressed against the screws—the great advantage of a mechanical stage, in being able to focus at the same time that the slide is moved, was lost.†

Fine-adjustment by tilting the Stage.—In describing Queen and Co.'s "New Laboratory Microscope, Acme No. 5," in which the upper stage-plate is lifted at one end by a screw, the writer says ‡ that this "plan of constructing the fine-adjustment has the following invaluable features, which especially fit it for class work in the laboratory.

First (and principally). Perfection of action: The upper plate, carrying the object, must respond instantly to the movement of the screw —upward by positive action, downward by the spring of the plate; and without any lateral or side motion; these, of course, are the essential features of a good fine-adjustment.

Second (and important). This perfect action will continue as at first; as there are no joints to wear loose or become strained, there can be developed no lost motion nor lateral motion by wear or rough handling, all being made practically in one solid piece.

* *Ante*, p. 334.

† Cf. Engl. Mech., xlvii. (1888) p. 117.

‡ Queen's Micr. Bulletin, iv. (1887) p. 44 (1 pl.).

Third. It is inexpensive in construction. An objection is sometimes made that one side of the stage-plate is moved, while the other is not, thus elevating one side more than the other. We only ask those to whom this may appear an objection, to make a practical and careful test. They will find that this objection is utterly invalid in practice, as the range of the motion required is very slight."

On the other hand it must be pointed out that this system of fine-adjustment is hardly tolerable for any but rough-and-ready elementary work, as the continual tilting of the stage-plate supporting the object renders the employment of substage apparatus very inconvenient, not to say practically impossible.

Amici adopted this mechanism in one of his models we have met with, one of which is shown in fig. 64, where the stage consists of a plate bent on itself, the upper half being pressed upwards by a screw, returning by its own "spring" when the screw is withdrawn. The more common form is that shown in figs. 65 and 66, where the stage does not consist of one plate bent on itself, but of two joined by a short bar at one end. A peculiar modification of this plan is shown in fig. 67, where the thick stage has a thin plate separated from its upper surface, which is raised at one end by a screw, as in the other cases. Fig. 68 shows another modification, adopted by Seibert, of Wetzlar, the stage being suspended between two pivots at one end and tilted by a screw at the other end, acting against the pressure of a spiral-spring.

Amici also adopted the system of suspending the stage (fig. 69) on pivots on either side of the pillar, an angle-piece being connected at the back forming a bent lever, by which the stage was tilted by a screw acting against a spring. Nobert modified this latter system, even with his largest Microscopes to which he applied his stage-micrometer, by suspending the stage on pivots on either side of the pillar, and attaching the angle-piece beneath the stage so as to be acted upon by a screw passing through the pillar; the downward motion of the stage acted by gravity only as in the small French Microscope shown in fig. 70, which instrument has in addition a peculiar crank-arm attached near the edge of the milled head, which raises and lowers the body-tube instead of the usual rack and pinion. This plan has been adopted in many of the commoner types of Microscopes issued in recent years in Germany, in some cases (as in the Microscope by Schieck, of Berlin, shown in fig. 71) the downward motion of the stage is controlled by a spiral-spring pressing on the front of the angle-piece.

Trécourt and Oberhäuser (fig. 72) avoided the tilting of the stage by making the upper plate move up or down in a horizontal position by means of a screw and socket at one end and a guide-pin at the other end. Charles Chevalier and others in France adopted this mechanism, with more or less modification; and in England, Pritchard, Carpenter and Westley, and others also employed the system. Fig. 73 shows the application of a rack and pinion with a guide-pin giving parallel motion to the upper stage-plate. This focusing by the stage was subsequently elaborated by the late Hugh Powell, for which he was awarded a silver medal by the Society of Arts in 1841, and which consisted in making the upper part of the stage, carrying the "Turrill" mechanism, to move upwards or downwards in the strictly horizontal position by a system of screws acting upon levers and wedges. Andrew Ross appears to have adopted this system also in some of his early constructions.

Fig. 64.

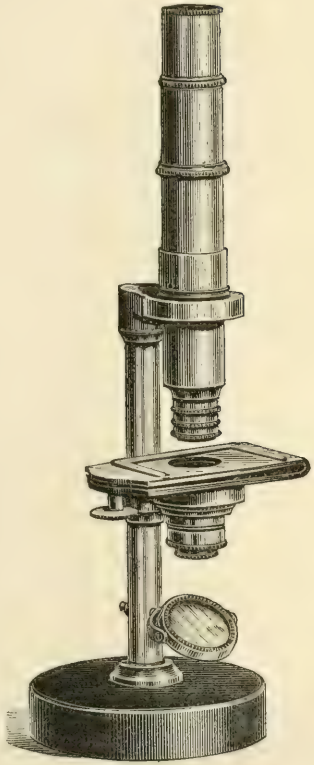


Fig. 65.

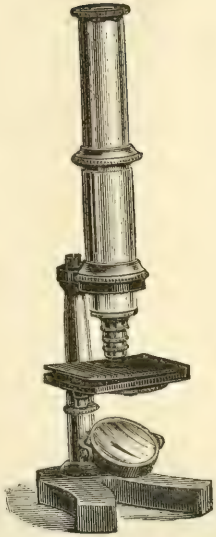


Fig. 66.

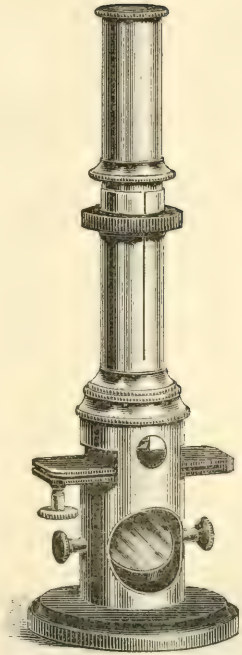


Fig. 67.

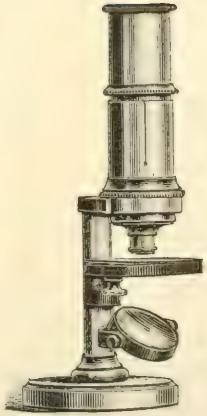
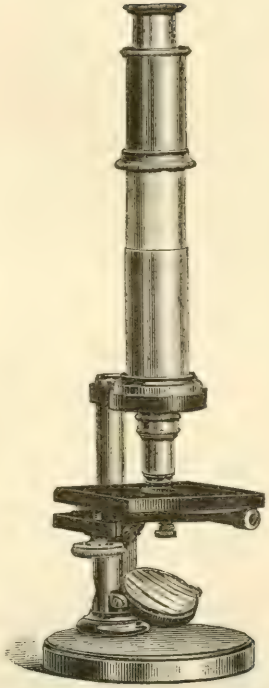


Fig. 68.



Microscopes with Stage Fine-adjustment.

Fig. 69. Fig. 70. Fig. 71. Fig. 72. Fig. 73.

MICROSCOPES WITH STAGE FINE-ADJUSTMENT.

It appears to us regrettable that so many opticians should struggle to issue "students'" Microscopes, the chief aim of which appears to be a low cost of production regardless of the modern requirements in such instruments. Our own experience is that with a stand well equipped with substage appliances for controlling the illumination, every good objective may be made to yield images at least 50 per cent. better than are possible without such appliances. A "student" should obviously commence his training in microscopy by learning to use his optical battery in the most effective manner, which practically necessitates his being provided with a stand altogether superior in construction to those usually supplied as "students'" Microscopes.

Since the above was written the writer of the article on which we were commenting replied * to a similar criticism as follows:—

"Another eminent professor, for whose opinion we have great respect, in reply to our argument in favour of the Acme No. 5, urging the inexpensive construction combined with thorough efficiency, of the fine-adjustment, presents the well-known theoretical objection to this form, and (while willing to admit that he might not be able to tell, by looking through the Microscope, which side of the stage was most elevated) says that in his experience expense is not an objection if the Microscopes are likely to be effective and durable in use in the laboratory. He considers it desirable to pay more and get instruments free from theoretical objection. He speaks of his experience in Germany with German laboratory Microscopes; how each year they required to be sent to the maker for repair. Right here is a strong argument in favour of the construction of the fine-adjustment adopted in the Acme No. 5. In instruments of the usual German type the operation of the 'slip-tube' brings a great strain on the slide of the fine-adjustment; in the Microscope above referred to the two adjustments are entirely separate, and there is no strain on the fine-adjustment from the use of the other; in fact, there is no slide or joint whatever that can wear loose. The slip-tube adjustment is carried upon a solid arm, to which it is firmly dovetailed and screwed fast. We are willing to admit that another form of fine-adjustment may be preferable for the expert engaged in work which requires the use of substage condenser, highest powers, &c.; but for the ordinary work of the histological laboratory we believe that it will prove eminently adapted. In the language of modern science, its structure being suited to the conditions of its 'environment,' it will survive, being of the 'fittest.'"

"**American Microscopes—A Complaint.**"—A great sensation has been caused in the United States by the publication † of the following article by Prof. C. S. Minot, condemnatory of American Microscopes. The author's criticism is much too sweeping and indiscriminate.

"Every autumn when the colleges and medical schools of the country begin their Academic years, there are many students who come to their instructors seeking advice in regard to the purchase of Microscopes. Often they appear already furnished with an instrument of which they are anxious to learn that the lenses are particularly good.

"As it has been my duty for several years to conduct a large class in practical histology, I have had frequent applications for advice about Microscopes, and have seen and examined a great many different

* Queen's Micr. Bulletin, v. (1888) p. 2. † Science, x. (1887) pp. 275–6.

stands, and the lenses of many manufacturers. I have had, therefore, opportunities to test the practical convenience and advantages of the many sorts of Microscopes which the students have brought along with them. The result of this experience is the conviction that it is undesirable to recommend a student to purchase any Microscope whatsoever of American manufacture, and to always counsel him to obtain, if possible, one of the German or French instruments.

"In order to make my judgment more clear, I may add that I know of no American Microscope which I should like to purchase at any price, for my own use in histological or embryological work.

"I venture to express this adverse opinion in regard to American Microscopes in the hope of inducing some of our opticians to manufacture a stand for a Microscope suitable for the use of students of histology and biology. It appears to me that the simple model now almost universally adopted in Europe is far superior to everything offered us in rivalry to them by our own dealers.

"To justify myself, I should like to give, first, the reasons for my disapproval of the American forms; and, second, the reasons for my preference of German forms. The fundamental error in Microscopes of American manufacture is that they are for the most part constructed with a view of, I might almost say, entrapping inexperienced purchasers. The zeal of the maker is turned too much to decorative lacquering and nickel-plating; he adds to his stand as great a variety of mechanical contrivances and adjustments as the price of the stand will permit, and many of these contrivances are not really commendable for their utility. In the majority of cases the stands are made to tilt, which, for one that uses the Microscope for real work, is an almost useless luxury, because he who really works in histology necessarily examines fresh specimens in fluids, or at least constantly has on the stage of his Microscope preparations in various stages of unreadiness, and not mounted in a permanent form. All this implies the constant use of fluids, and, if the stage of the Microscope is inclined, the use of liquids is impracticable. Any one, therefore, who uses his Microscope for the ordinary purposes of a student or an investigator, or in connection with clinical or pathological work, very soon falls out of the habit of tilting his Microscope. Hence it is, that, while making a Microscope to tilt renders it considerably more expensive, it adds nothing essential to the convenience of the stand for laboratory work. This same fact, that most of the work must be done with the tube of the Microscope vertical, renders it indispensable that the Microscope should not be too high; so that we must put down the ten-inch tube as a bad feature for a student's Microscope. A rack and pinion is undoubtedly advantageous; it renders the use of the Microscope more convenient, and increases its durability by diminishing the strain upon the stand during the coarse adjustment of the focus. When this adjustment is effected by shoving the tube with the hand, the Microscope wears out sooner than with the rack-and-pinion movement; yet even the rack and pinion, which are so generally put on our American Microscopes, are not indispensable, and the greater part of the histological and embryological investigations of the past twenty years have been made without the employment of this convenience.

"The stage of the American Microscope is very faulty. The large movable glass plate with a hole through it is a toy fit only for an amateur or fancy collector; it interferes with the use of fluids, and with

the freedom of movement of the slide over the field of the Microscope—the two things which are most indispensable in practice. A good stage should be large and flat, with nothing upon it except a pair of spring clips and a hole for a diaphragm. The diaphragms are often a matter of particularly fanciful construction. Thus the iris diaphragm is often introduced to allure the inexperienced, but it is not a good form except in conjunction with an achromatic condenser. There are other details of construction which are equally open to unfavourable criticism, but it is unnecessary to go into their discussion.

"Unfortunately, while we see so much pains expended upon the brasswork of the Microscope, we see a neglect of the optical members of the instrument; so that the Microscope as a whole is converted into a showy piece of apparatus, and the eye-pieces and objectives are generally, though not always, of a decidedly inferior character; when they are really good, the lenses are very expensive.

"If, now, our manufacturers would reverse the distribution of their painstaking, and make a simple stand of small size and compact model with first-class lenses, they would furnish something which could be recommended to students and others by conscientious advisers.

"Turning now to the consideration of Continental Microscopes, so universally used in Europe, and now happily gaining supremacy in this country, we see at once that they conform to the practical requirements which are disdained in the making of most American Microscopes.

"They are built with a firm base. The stage is easily reached by the fingers when the hand is resting upon the table. It carries no superfluous appurtenances, but is large and flat. The eye-piece is of such a height, that when the instrument is vertical it is easy to look into it. Concerning the lenses, it must be said that most of the European manufacturers are very conscientious in regard to those which they furnish. There are, of course, some makers who put upon the market objectives of inferior quality, and which are sold as such, and therefore at a correspondingly low price. This is of course legitimate, as there is a demand for cheap Microscopes.

"The price of these desirable Microscopes is very much less than that of undesirable American ones. According to our system of protection, the physicians, scientific men, and students are taxed enormously if they buy a foreign instrument. Put into plain English, this means that we are heavily fined if we secure what we require in the way of Microscopes, while a small number of manufacturers, whose money-making is of very little significance to the public, receive a bonus for furnishing an inferior article at a high price. Thus what is really important is sacrificed for what is unimportant. Many valuable members of the nation are sacrificed by being obliged to pay for the advantage of a small number of men who have never shown themselves willing to supply to those by whose sacrifices they benefit, the kind of instrument wanted.

"Can anything be more unjust? and are not we, who are engaged in university careers, in the practice of medicine, or any other useful occupation requiring the employment of Microscopes, justified in complaining of the condition of affairs, which is little short of a national calamity? Is it unreasonable to ask the manufacturers of Microscopes in this country to furnish us instruments of the kind we really need, as some sort of acknowledgment of the money they extract from us whether we will or not?

"In expressing myself so decisively and emphatically upon the subject of American Microscopes, I have not considered it necessary to give a detailed discussion of the relative merits and demerits of the different makes, because what I have expressed is the opinion, in these matters, of all the competent judges with whom I have talked on the subject.

"I know positively that many of the best scientific men of America are ready to join me in saying, as I said at the beginning, that there is no American Microscope which we should like to buy at any price for our own use."

In reply to some comments * to which his article gave rise, Dr. Minot wrote as follows †:—

"The object of my letter in 'Science' was to direct attention to a special need which I believe to exist in this country. This need is one which has arisen in consequence of the introduction of the Microscope as an aid to the educational courses of American colleges and medical schools. There the requirement is that the Microscope shall be as inexpensive as possible. Now, a Microscope must fulfil one indispensable requirement, it must be optically good. If the lenses are inferior, the value of the instrument is excessively diminished.

"Pretty much all the other qualities of the Microscope may vary without affecting anything but the convenience of the Microscope. It is therefore evident that it is solely in regard to the stand that the economy must be effected. I hold, therefore, that the ideal student's Microscope must have the simplest construction possible, and that nothing should be added to it which can be left out, and still leave the instrument sufficiently convenient for actual use. The hinged joint for tilting, the rack and pinion, and the iris diaphragm all increase the expense of the Microscope, and yet do not add anything indispensable.

"In Germany Microscopes are very little used by amateurs, but are extensively used by scientific investigators and students; accordingly, we find the stands which are made in that country adapted to the demand. A similar demand has arisen in this country, and will probably grow, and I should suppose that it would be for the interest of American manufacturers to meet this demand rather than to leave the market to European makers without competition."

Buffalo Microscopical Club.

[Protest against Prof. Minot's article on American Microscopes, *supra*, p. 482.]

The Microscope, VIII. (1888) pp. 55–6.

HENRICI, J. F.—**Recently-discovered Microscopes of historic interest.**

[Describes and figures two Microscopes—(1) cf. *post*; (2) a Culpeper, "the exact counterpart in every particular of one figured in plate iv. of Adams's 'Essays on the Microscope' (1787)," with the addition of a rack and pinion for focusing.]

The Microscope, VIII. (1888) pp. 97–9 (2 figs.).

SCOTT, G. P.—**[Exhibition of a Microscope.]**

["This Microscope possesses many ingenious appliances connected with the body, the stage, and the substage of this instrument. Especially noticeable among these are the contrivances by which, with a quarter revolution, the polarizer, the selenite, and the analyser of the polarizing apparatus can instantly be brought into use or turned to one side, so as to avoid all interference with the examination of an object by ordinary light."]

Journ. N. York Micr. Soc., IV. (1888) p. 120.

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* Cf. inter alia Queen's Micr. Bull., iv. (1887) pp. 41–3; also v. (1888) p. 4.

† Queen's Micr. Bull., v. (1888) p. 8.

(2) Eye-pieces and Objectives.

The Jena Optical Glass.*—Mr. J. Swift states that the difficulties in the practical use of this glass has been great, "for nearly the whole of the new glass purchased by him was found to be worthless, so rapid was the deterioration of most of the samples; and some systems of lenses made of them became pitted on the surfaces within a week after the manufacture. He found about three stable samples in the whole of a very large batch." Figs. 74 and 75 represent in the actual dimensions the eye-piece and objective of a Microscope made entirely of the new materials. In fig. 74, A, B, and C are of the new crown glass, and D of the new flint. In the objective, fig. 75, A is the aperture above the compound lens B C; B is of hard crown, C of flint, D crown,

Fig. 74.

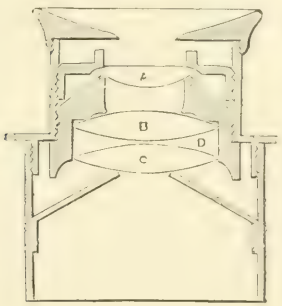
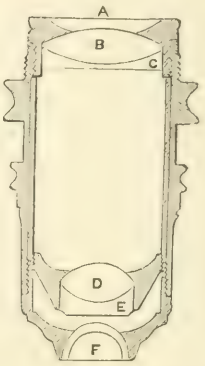


Fig. 75.



E flint, and F a plano-convex crown element of deep curvature, cemented to the meniscus flint element above it. Although it is difficult work to make an objective entirely of the new glass in its stable forms, Messrs. Swift use the glass now in all their Microscopes to some extent for objectives varying from the 1/12 in. immersion to the 3 in.; the benefit, they state, is that the 2 in. objective which formerly had an angular aperture of 15°, with the new glass has an angular aperture of 22°, and strange to say, instead of being dearer it is cheaper, because with the good samples of the new glass the manufacturing optician is more sure of his results. As regards the eye-piece, fig. 74, Mr. Swift says:—"It would be very difficult to use the ordinary Huyghenian eye-piece of the same power, as the loss of light would be so great that the detail the objective would be capable of picking up would not be seen, or the eye would have to be nearly in contact with the eye-piece, to enable the object to be seen, but with the eye-piece shown the focal distance is so increased that it can be used with as much ease as one of the ordinary construction with a magnification of only ten diameters."

Bausch, E.—**Society Screw.**

[Condemns the ambiguity of the instructions of the original committee, and urges that something should be done to get a better standard.]

The Microscope, VIII. (1888) p. 127.

* The Engineer, 1888, March 2, pp. 182–3 (2 figs.).

L., A. S.—**Inquiry as to the best proportion of Eye-piece to Objective.**
Engl. Mech., XLVII. (1888) pp. 169–70.

Objectives, English and Continental.

[Inquiry "how to compare the English and Continental nomenclature of objectives."

Reply by "T. F. S." that such a list as desired "would be impossible, from the simple fact that the magnifying powers of the objectives as supplied by the makers do not agree with their own catalogues." He then proceeds as follows:—

"Within certain limits, however, the focal distance of the objective is not of the slightest importance, the numerical aperture being the only measure of its capacity to show fine detail. Thus if a 1/4 in. and a 1/8 in. objective have the same N.A., and an object is shown under the first with an eye-piece magnifying eight, and under the latter with an eye-piece magnifying four times, there will be no difference between the images whatever, neither in brightness nor in the amount of detail shown, provided both glasses are equally corrected. The measuring the capacity of an objective by its focus is an old superstition handed down from the time when the angle had to be limited from a want of skill in making the necessary corrections for chromatic and spherical aberration, and like most superstitions, has lingered for a long time after the cause, which made it a real faith, has disappeared. I can only, then, counsel 'A Constant Reader' to throw aside all notions of measuring the capacity of a glass by its focal length, and in its place to study the 'Aperture Table' given in the 'Journal' of the Royal Microscopical Society, where he will find the resolving power for any given aperture, and can then compare catalogues for himself."

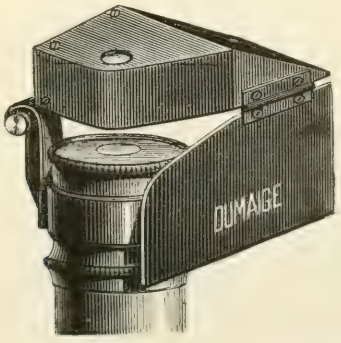
It cannot, however, be quite so broadly laid down that the "focal distance of an objective is not of the slightest importance." Even when resolution is alone considered there is a proper relation between aperture and power which renders a knowledge of the latter important.]

Engl. Mech., XLVII. (1888) pp. 125 and 146.

(3) Illuminating and other Apparatus.

Dumaige's Camera Lucida.—The peculiarity of M. Dumaige's camera lucida is that the prism and reflecting mirror are in a box, which can be closed when the camera is not in use. When in use the cover of the box hangs down at the side of the eye-piece, as shown in fig. 76. The optical arrangement consists of a small prism over the eye-piece, covering half

Fig. 76.



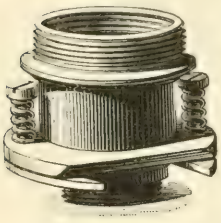
the eye-lens, with a mirror about 1 in. square which receives the image of the paper and pencil and reflects them to the prism, whence they are reflected to the observer's eye, which views simultaneously the image from the object through the uncovered half of the eye-lens. The

prism is mounted on a short pin on an adjustable slide at the side of the box.

Eye-shades.—These "shades," intended to be placed in front of the unused eye in microscopical observations, have hitherto been blackened, but it is suggested * that it would be preferable if they were white.

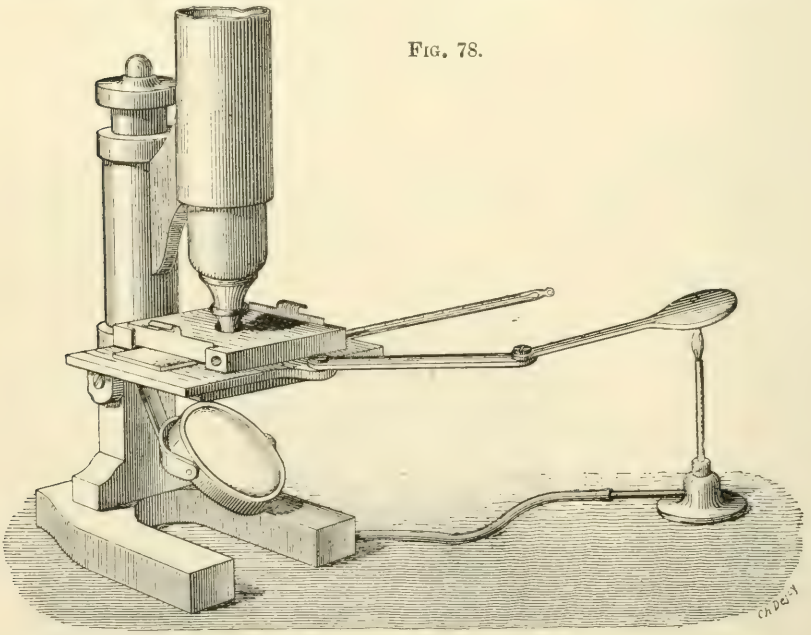
Dumaige's Nose-piece for Changing Objectives.—This device (fig. 77) of M. Dumaige somewhat resembles that of the Geneva Physical Instrument Co., described in this Journal, 1884, p. 284. It differs from that, however, in the use not of two hinged plates kept together by a set screw acting on a spiral spring, but of two spiral springs, as shown in the figure, which press the lower horseshoe plate against the adapter. The objective is provided with a sloping flanged collar, which is slipped between the lower plate and the adapter, and is held fast by the action of the springs. In order to further secure it there is an annular countersunk piece in the adapter into which the collar fits.

Fig. 77.



Malassez's Hot Stage.†—M. L. Malassez has devised a hot stage which is both simple and handy. It consists (fig. 78) of a metal

Fig. 78.



plate, covered over so as to form a box, into which the preparation is slipped. From the front of the plate projects a flat double arm, also of

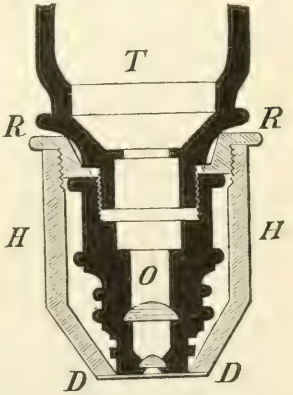
* Queen's Micr. Bull., v. (1888) p. 5.

† Arch. de Physiol., viii. (1886) pp. 271–3 (1 fig.).

metal. The end of the arm is expanded in order to be more readily heated. The sides of the hot chamber or box are of unequal thickness, the side farthest from the arm being the thicker, in order that the temperature of the side from which the arm projects and that of the opposite side may be about equal. This is shown by putting little pieces of paraffin on the top of the box, for they melt at almost the same time. A thermometer is placed within the chamber to mark the temperature, and this may be made to rise more or less quickly, according as the expanded end of the arm is more or less heated, and thus the temperature be kept fairly equable. If, however, a constant temperature be necessary, the author advises the use of M. Vignal's hot stage. The one described, however, is much more simple, and quite suitable for most purposes. The instrument may also be used for cooling down preparations by using methyl chloride on the expansion at the end of the arm.

Hällstén's "Compressorium."*—Dr. K. Hällstén apologetically calls his apparatus a compressorium for want of a better name, for its main use is intended to safeguard the face of the objective from the deposit of vapour while examining the circulation of the blood, e. g. in the chick. It may, however, be used as a compressorium for flattening out or exerting equal pressure upon the parts of a specimen.

Fig. 79.



The apparatus (fig. 79) consists of a cylindrical brass tube H, which surrounds the objective and carries the cover-glass D so that watery vapour is prevented from reaching the objective or face of the lens. R is a ring into which the upper end of the brass tube is screwed. This ring is screwed in between the body-tube T and the objective O. The cover-glass DD is fixed to the lower end of the compressorium tube by an alcoholic shellac solution. When in use the tube can be screwed down so that the cover-glass penetrates within the examining fluid and comes in contact with the blastoderm, and observation is unhindered by the presence of vapour.

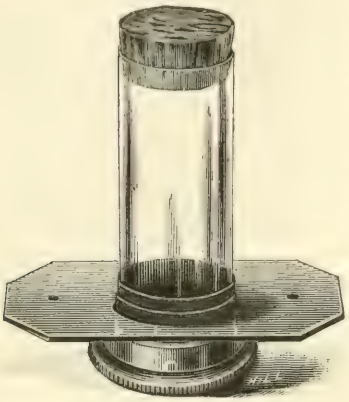
When the apparatus acts as a compressorium, the action is effected by merely screwing or pushing the tube down upon the object.

Hardy's Growing Slide.—Mr. J. D. Hardy writes:—"The absolutely necessary qualities of a growing slide are that there should be a perfectly free current, that the water supply should be pure or devoid of any extraneous matter, and that the object should be observable at any time. To carry out these desiderata I use apparatus shown in fig. 80 consisting of the old 'animalcule box' of $1\frac{1}{4}$ in. in diameter. At the upper part of the raised cylinder a small vertical slit is made half-way down. On the opposite side a hole is drilled in the bottom of the groove which runs round the central glass disc. A hole is drilled in the side of the cap about half-way down, so that when the cap is pressed close down the

* Zeitschr. f. Biol., xxii. (1886) pp. 404–7 (1 fig.).

hole is below the bottom of the slit. The compressor is now inverted, and a bottle or tube, made to fit watertight, and having a small hole in the side at the bottom, is inserted in the well. The hole in the bottle and that in the bottom of the groove are plugged with cotton-wool, either loosely or tight, according as the flow of water is desired. The water flows through the hole in the bottle, and then through that in the bottom of the groove, and so between the glass covers containing the object, passing out through the slit and the hole in the cap. The flow can be so regulated that it may take either a day or an hour to empty the bottle, which will contain about one fluid ounce. The cotton-wool plugs completely stop any foreign substance passing. When observation is required, the bottle being removed, the water will remain in the life-box, or it may be at once rendered watertight by turning the hole in the cap away from the slit."

Fig. 80.



Schieck's Microscope Lamps.—Herr J. W. Schieck has devised the lamps shown in figs. 81–4.

Fig. 81.

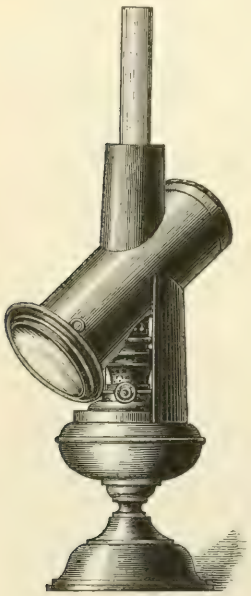
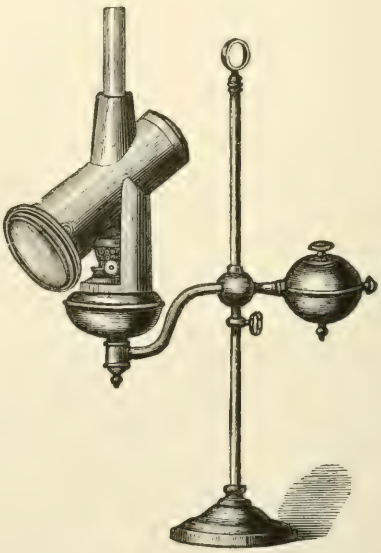


Fig. 82.



The pecularity of the two former (which differ only in their mounting) is the metal shade and reflector, which is shaped as shown in the figs.

with a condensing lens in the lower end. The two latter have a hinged shade which can be placed in different positions in front of the lens according to the illumination required.

Fig. 83.

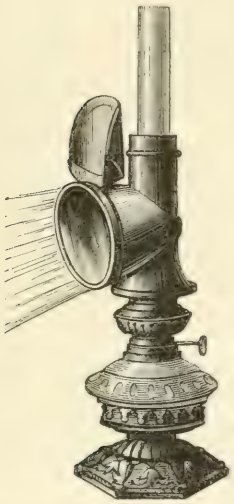
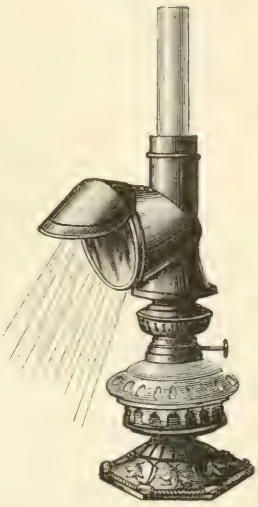


Fig. 84.



Gerlach's Embryoscope.* — The embryoscope, devised by Dr. L. Gerlach, supplies a great and long-felt desideratum in experimental embryology. It is a mechanism for closing hermetically a circular opening, made with a trepan, in the shell of the hen's egg; and it serves the purpose of a window, through which the living embryo may be directly observed, and its development followed from day to day.

The instrument consists of two parts:—(1) A mounting-ring to be firmly cemented to the egg-shell. (2) A key-piece with glass front, which screws into the ring and closes it air-tight.

Fig. 85 represents the embryoscope in perspective, and fig. 86 in section. The metallic mounting-ring is $1\frac{1}{4}$ mm. thick, and has a lumen 2 cm. in diameter. The lower edge *Ar* is bevelled and saddle-shaped so as to fit the equatorial surface of the egg, while the upper edge is flat. From the outer surface of the ring two square-cornered bars Z project in opposite directions. On its inner surface, a little above the lower edge, is a diaphragm *Md* with an opening 13 mm. in diameter. Resting upon this diaphragm, and corresponding with it in size and shape, is a second diaphragm of thin wax-cloth *Wd*, which serves as a packing-washer for the key-piece.

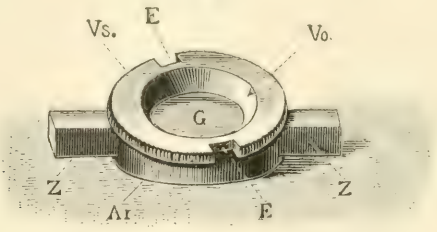
The key-piece of the embryoscope consists of a low metallic cylinder, closed by a disc of glass G, which represents the window that is to cover the artificial opening in the shell. The upper part of the cylinder expands peripherally to form a rim with a milled edge *Vs*. This rim has two notches E opposite each other, into which fit the arms of a small wrench, by the aid of which the key-piece can be tightly screwed down.

* Anat. Anzeig., ii. (1887) p. 583 (2 figs.).

There is also a short, narrow vertical canal *Vo* or vent, the lower end of which must open in the middle of the key-piece ring.

The accessory apparatus required in the use of the embryoscope consist of (1) a trepan; (2) a guide-ring for the same; (3) a metallic fork; and (4) the key or wrench before mentioned.

Fig. 85.



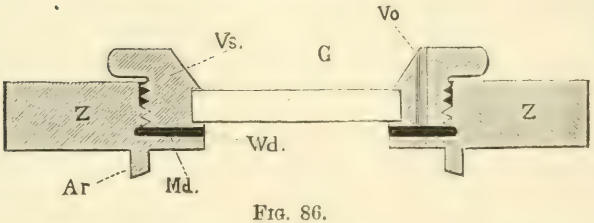


Fig. 86.

The trepan is a thin metallic cylinder, 2 to 2½ cm. long, the lower end of which is toothed, while the upper part is fluted and serves as the handle. The diameter of the trepan is a trifle smaller than that of the opening of the diaphragm. The object of this is to leave a very narrow zone of shell, covered with shellac, inside the inner edge of the diaphragm.

The guide-ring for the trepan has the same construction as the key-piece, except that it has no glass disc. It serves to steady as well as guide the trepan during the process of cutting.

The fork has two notches at the ends of its prongs fitted to receive the two bars of the mounting-ring. When adjusted to the bars, the fork serves as a means of holding the embryoscope securely while screwing or unscrewing the key-piece.

The wrench, the use of which has already been explained, is similar in construction to the wrench used for mathematical instruments.

The mounting-ring is fastened to the egg by means of a cement consisting of two parts of wax and three parts of colophonium. The cement is hard and brittle at the ordinary room-temperature, but becomes soft and kneadable when held in the hand for a few moments. After warming the mounting-ring over a gas or a spirit-lamp, a roll of the softened cement is pressed into the space which must be completely filled between the lower face of the diaphragm and the lower edge of the ring. As soon as the ring becomes sufficiently cool, it is pressed firmly to the equatorial surface of the egg, and the excess of the still soft cement, which is thus forced outward and inward beneath the ring,

should be removed before it becomes brittle by the aid of a small, sharp-pointed blade. In order to avoid injuring the blastoderm, which might occur if the hot ring were fastened to the shell directly over it, it is best to fix the ring to the side rather than the top of the egg.

After the ring has been securely fixed and the superfluous cement removed, the exposed edges of the remaining cement seen beneath the lower edge of the ring and the inner edge of the diaphragm, must be covered with a coat of an alcoholic solution of yellow shellac. This may be applied with a small brush, care being taken to cover the cement completely, and as little of the egg-shell as possible.

After the shellac has dried, a process which is completed in twelve to fourteen hours in the open air and in six hours in the incubator, the shell may be trepanned.

Antiseptic precautions are required in opening the egg. An oblong porcelain trough or glass dish is first filled with a 3 per cent. solution of carbolic acid, and in this are placed the instruments to be used in the operation: a glass rod, a medium-sized brush, small shears, forceps, the trepan, and the guide-ring. Before using, these instruments are dried with carbolized cotton, and after using, returned to the dish of carbolic acid.

After washing the hands in dilute sublimate, or carbolic acid, a perfectly fresh egg is painted with the 3 per cent. solution of carbolic acid, and then dried with carbolized cotton. The small end of the egg-shell is then cut out with the shears, and the thick white poured with the aid of the glass rod into a clean dish, leaving the yolk and the thinner white in the shell. The white is to be used in screwing in the key-piece, and must therefore always be prepared beforehand.

After these preparations, the egg to which the mounting-ring has been cemented is disinfected in the manner above described, and placed in an egg-carrier with the ring uppermost. The inside of the ring is then brushed with carbolic acid, which is shaken out after one or two minutes, and replaced by a 1/2 per cent. solution of common salt, which is also allowed to remain from one to two minutes, and then completely removed by means of carbolized cotton. The guide-ring is now screwed in, and the egg trepanned from the side in order to avoid injuring the blastoderm. The egg is next placed with its opening upward, and the guide-ring removed. When the trepan is withdrawn, the excised piece of shell often comes with it, and sometimes the underlying shell-membrane. If this is not the case, the two pieces must be removed separately by the aid of the pincers. Care must, of course, be taken not to injure the blastoderm and the *zona pellucida*.

The thin white, which was left with the yolk in the shell, is allowed to flow over the glass rod upon the exposed blastoderm until the ring is filled, care being taken to avoid air-bubbles. The wax-cloth diaphragm is next taken from the dish of carbolic acid, dried in blotting-paper, drawn through the thick white, and inserted in the ring in close contact with the metallic diaphragm, and then the key-piece, previously washed with carbolic acid, and dried with carbolized cotton, is slowly screwed down. The superfluous white is thus slowly forced out through the vent *Vo*, until the key-piece reaches the diaphragm and closes the vent. Finally, when the strength of the hand is no longer sufficient, the egg with its embryoscope is placed in the metallic fork, and the wrench applied, until with this means it is no longer possible to turn the key-piece farther.

The process of trepanning and inserting the key-piece is somewhat more complicated in the case of eggs that have already been incubated, as the egg and the fluids employed must be kept warm. A water-bath is required, consisting of a low tin box, filled with water, and provided with covered apartments for the reception of the egg, the thin white, the carbolic acid, and the salt solution, which are in this way maintained at a proper temperature. In other respects, the mode of procedure is exactly the same as given above.

The key-piece may be removed as often as desired, provided the above precautions are taken each time in inserting it. If the key-piece is unscrewed by means of the fork and wrench, it must, of course, be washed in the warm carbolic acid, and the vent cleared by the introduction of a wire. The egg must be placed in the incubator with the embryoscope on one side. If it is placed upward the respiration of the embryo is hindered. The embryoscope can be turned up at any moment, and kept upright for five minutes at a time without injury to the embryo. With a little practice the whole process of arming an egg with the embryoscope may be completed in from six to eight minutes.

The embryoscope is well adapted for purposes of class-demonstration, for investigating the growth of the various parts of the embryo, and the physiological processes during embryonic life, as the action of the heart, movements of the body, &c. It is indispensable to the study of the effects of external agents upon the embryos of warm-blooded animals, and must be of great service where it is required to determine the precise stage of development before removing the embryo from the egg. It has been found useful in studying the formation of double embryos. Fenestrated eggs have been successfully incubated up to the thirteenth day, and it is probable that, under favourable conditions, the embryos of such eggs would reach maturity.

On the fifth day it is still easy to bring the embryos under the window. On the sixth and seventh days it is more difficult. At this period the change in the position of the embryo, which requires from five to ten minutes, should take place in the incubator.

After the eighth day the embryo cannot be brought under the window. If it be necessary to determine whether such an egg or an older one still lives, we have only to leave the egg for several hours in the incubator with the window directed upwards a little, after which, by strong reflected light, one may readily see the blood circulating through the channels of the vascular area.*

Curtis, J. S.—**The Quantitative Determination of Silver by means of the Microscope.**

[Describes a "micrometer measuring apparatus," consisting of a Microscope with a vertical and two horizontal cross hairs and a mechanical stage.]

6th *Ann. Rep. U.S. Geol. Survey*, 1885, pp. 323–52 (1 pl. and 2 figs.).

Malassez, L.—**Sur quelques nouveaux Appareils. II. Hémochromomètre perfectionné.** (On some new apparatus. II. Improved hæmochromometer.)

Arch. de Physiol., VIII. (1886) pp. 261–8 (2 figs.).

Ney, O.—**Magnesiumlampen.** (Magnesium lamps.)

[The magnesium ribbon is unrolled from a wheel at the back of the apparatus, and there is a patent adjustment for the burner which removes the ash by means of a clockwork motion with brushes, rollers, revolving discs, or some such mechanism. Three kinds are figured, one representing the lamp in the form in which it can be used directly with suitable lenses or mirrors for

* Cf. Dr. C. O. Whitman in Amer. Natural., xxii. (1888) pp. 186–90 (2 figs.).

general purposes of illumination. A second, in which it is shown as applied for projecting microscopic objects, &c.; it is claimed that as an illuminator for this purpose it is far superior to petroleum lamps as being free from smell and from excessive heat, and at the same time more brilliant. The third is a special form for photographic illumination.]

Central-Ztg. f. Optik u. Mech., IX. (1888) p. 82 (3 figs.).

Pulfrich, C.—**Ein neues Refractometer, besonders zum Gebrauch für Chemiker eingerichtet.** (A new refractometer, specially intended for the use of chemists.)

Zeitschr. f. Instrumentenk., VIII. (1888) pp. 47–53 (2 figs.).

Seifert.—**Ueber das Auer'sche Gasglühlicht.** (On the Auer incandescent gas burner.)

[Recommendation of the Auer von Welsbach light (known in England as the *Welsbach*) for microscopical observations, examination of the nose, ear, &c.]

SB. Physik.-Med. Gesell. Würzburg, 1887, pp. 11–3.

(4) Photomicrography.

Cross, C. F., E. J. Bevan, C. M. King, E. Joynson, and G. Watt.—**Report on Indian Fibres and Fibrous Substances exhibited at the Colonial and Indian Exhibition, 1886.**

[Contains a description of the photomicrographic apparatus and the method of working, pp. 13–6, 1 fig.]

viii. and 71 pp., 5 pls. of photomicr., 8vo, London, 1887.

[Manton, W. P., and others.]—**Photomicrography.**

[Urging that the "helpful devices and methods" of workers should be "written up and published for the general good, and not held secret for individual benefit."]

The Microscope, VIII. (1888) p. 89.

Nelson, E. M.—**On the Formation of Diatom Structure.**

[In exhibiting some photomicrographic positives of diatoms, Mr. Nelson said, "I believe we are on the verge of a new departure in the field of microscopical work, viz. illustration by means of lantern pictures from photomicrographic positives."]

Journ. Quek. Micr. Club, III. (1888) pp. 201–2 (1 pl. of photomicr.).

(5) Microscopical Optics and Manipulation.

Learning to see with the Microscope.*—Mr. E. B. Poulton, in a review of the new edition of Huxley and Martin's 'Course of Elementary Instruction in Practical Biology,' writes on this subject as follows:—

"The most striking thing in the revised form of 'Practical Biology' is the reversal of the old arrangement, so that the student is now led to begin with a vertebrate type, and from this to work his way down to the lowest forms of life, and from these again upwards to a type of the flowering plants. There is little doubt that such a change will be met by conflicting criticisms. I believe, however, that the majority of those who have had the widest experience of biological teaching, and especially those who have instructed students in the first use of the Microscope, will heartily agree with Prof. Huxley's defence of the alteration in the preface to the revised edition.

"The process by which the student first learns to see with the Microscope is almost like the education of a new sense-organ suddenly conferred upon a mature organism. We know that under such circumstances it would be a very long time before the impressions conveyed by the new organ could be harmonized with the well-known experiences resulting from the stimulation of other organs. Accustomed to judge of the shapes of objects by their appearance in three dimensions, the student is suddenly provided with a field of vision in which shapes have

* Nature, xxxvii. (1888) pp. 505–6.

to be nearly always inferred from the appearance of solid three-dimensioned objects when seen under conditions which prevent them from being examined in more than two dimensions at any one time. For it is a long time before the student can accustom himself, by focusing at successive depths, and by making the most of the limited third dimensions of depth which the high powers of the Microscope provide, to judge accurately of the forms of objects. And the novel conditions under which a student sees with a Microscope effectually prevent him from making the best of the impressions he receives. Thus, if the section of a solid object presented the appearance of a circle 1 inch in diameter, and if two other sections at right angles to each other and to the first section presented the appearance of a rectangular figure 3 feet by 1 inch, nearly every one would readily infer that the shape was that of a cylinder 3 feet long by 1 inch in diameter. But precisely similar data when presented in the field of the Microscope, do not readily lead the student to any definite conclusions as to the forms of objects, and in reality a long course of discipline is necessary in order to make him form any clear conception of the actual shape of the object at which he is looking.

"I therefore think that it is expedient to begin the course of biological teaching with organisms which only require the use of a Microscope for the investigation of part of their structure, and thus to gradually work downwards to the minutest organisms, in which the whole investigation depends upon high microscopic powers. Thus the gradual training in the use of the Microscope will proceed parallel with its gradually increasing necessity."

Cover-correction.—Herr C. Reichert considers* that the "importance of 'cover-correction' by means of a screw collar is not so great as it once was, because, in the first place, it is now possible to readily obtain cover-glasses of a definite thickness, and, in the next place, because all good Microscopes are now provided with a draw-tube. In all high-class instruments, the draw-tube forms an important part, and is less intended to increase the magnification than to correct for the difference in the thickness of the cover-glasses. By means of varying the length of the tube, we are able to produce an effect upon the image similar to that which is the result of making the back lenses approach or recede from the front lenses of the objective. The effect due to varying the tube-length is noticeable in an objective such as No. 5, which has a focal length of about 1/16 in., and is more marked as the power of the objective increases. For example, if an objective having a focal distance of about 1/10 in. be corrected for a cover-glass 0·17 mm. thick, when the tube is half drawn out, it may, by shortening the tube, be made suitable for cover-glasses having a thickness of 0·25 mm. to 0·30 mm.; and if the tube be fully drawn out, the objective will then be suitable for cover-glasses from 0·14 to 0·12 mm.

"Those commencing microscopical studies should make themselves familiar with the influence exerted by the varying length of the tube, and this may conveniently be done by studying a delicate test-object, such as *Pleurosigma angulatum*, when the tube is extended or shortened in the manner already described."

* Reichert, C., 'Directions for using the Microscope,' translated by A. Frazer. 8vo, Edinburgh, 1887, 12 pp. (2 figs.).

On this point we will observe that the student will find his range of experience much increased by varying the position of the mirror so as to make the illumination more or less oblique. The differences between the positions of the draw-tube required to obtain the more perfect definition will thus be much more plainly appreciable by the untrained eye, and he will thus learn to discriminate at a glance when he is obtaining the best images his objectives will produce.

Further, this method of practice should also be adopted in conjunction with the correction-collar of the objective, which should be turned slowly from end to end of its range in one direction, and then in the other whilst following the varying focus by the other hand on the fine-adjustment. The eye and the hand will thus be trained to the *skilful* employment of the Microscope, a matter which has been far too much neglected hitherto.

It is a subject of common observation by opticians that the great majority of Microscopists have no practical training in the use of a correction-adjustment in improving the quality of the image under varying conditions of the illumination and with different thicknesses of cover-glass. Through neglect of such points the student drifts into regarding the correction-adjustment as useless; hence, he too frequently contents himself with mediocre definition, when his Microscope is capable of superior work if only properly handled.

Adjusting an Objective for the Thickness of the Cover-glass.—In a description of their "National" Microscope, Messrs. R. and J. Beck give directions for adjusting an objective, which are conveniently arranged

Fig. 87.

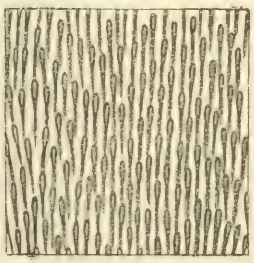


Fig. 88.

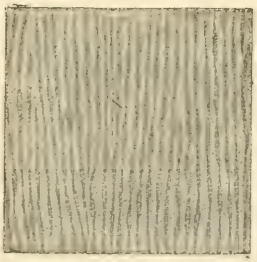


Fig. 89.

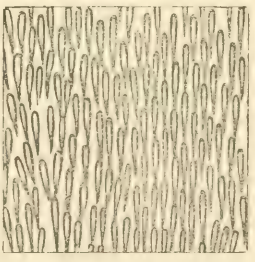


Fig. 90.

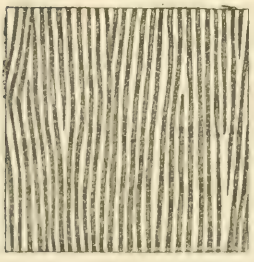
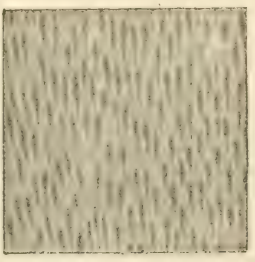


Fig. 91.

Fig. 92.



for the use of the student microscopist, and with these they give the following figures showing the appearance of a Podura scale when (fig. 87)

the adjustment of the object-glass is correct; the effect (fig. 88) produced on each side of the exact focus; and the way (fig. 89) in which the markings individually divide when all the adjustments are correct, and when the focus is altered the least possible amount only each way.

Figs. 90 and 91 show the two appearances on one and the other side of the best focus when the adjustment is incorrect; fig. 92 showing the appearance of the same at its best focus.

Villi on the Scales of Butterflies and Moths.—Dr. G. W. Royston-Pigott considers * that the resolution of these difficult objects is a capital introduction to the study of the minute structure of disease germs, and he can consequently strongly commend it to the attention of microscopists who have neglected this department of natural history.

Many of the villi in butterfly and moth scales are pawn-shaped, possessing a base and a spherical summit. This form was the first one discovered, with exceeding difficulty, on the scales of the Red Admiral butterfly. The scales of *Amathusia Horsfeldii* gave clearer indications, but their extreme delicacy permits of no pressure being applied, as it flattens and distorts them. After seven years' prosecution of the research he was rewarded with finding an entirely new vein, which has proved very rich in material, in moths of the *Zygæna* tribe. Occasionally they are seen to lie flat upon the basic membrane, and to be connected by cross ramifications, interlacing in an extraordinary manner. At other times the bases of the villi are ciliated, forming reticulations, resembling ancient hieroglyphics or archaic writing. Their thickness varies from 1/60,000 to 1/120,000 in., and their length is sometimes prodigious.

The villi principally observed at present take the following forms:—i. Beaded villi; ii. Embossed villi; iii. Pillar villi; iv. Ciliated villi; v. Connected villi; vi. Banana or Bunched villi; vii. Spinous villi; and viii. Tall villi.

Out of about 400 preparations (dry mounts) of scales obtained from all parts of the world, the author selects a few which with good object-glasses give, he considers, some startling results. Only a brief abstract is, however, given of the appearances.

Mr. T. F. Smith considers † that some of the appearances described in the paper are due to the villi being seen out of focus. In his view they are in between the two membranes of which the scales are composed, their use being to keep the two surfaces of the scale apart, and they are longer or shorter according to whether the surfaces are more or less rounded. He had seen some of the appearances, but only by taking too deep a focus. "As for the beading, he had never seen it, and he was strongly inclined to the belief that it arose from Dr. Pigott's methods being in some way at fault. He believed from what he had read that Dr. Pigott worked with a very small aperture, and if any one wanted to produce false appearances they could not go a better way to work; by using the lowest aperture of the condenser the same effects could be produced. With regard to Dr. Pigott's test rings, he knew that appearance perfectly well; but it was again a false effect due to the results of using too small an aperture."

Mr. Smith also shows ‡ that "some very respectable beads" may be

* Journ. Quek. Micr. Club, iii. (1888) pp. 205–7.

† Ibid., pp. 234–5.

‡ Ibid., p. 204.

developed by using the smallest aperture of the condenser, but that they instantly vanish when the light is restored.

There can be very little doubt that Mr. Smith is right in his criticism, and that it is Dr. Pigott's defective methods of manipulation that have led him astray in this matter.

New Appearances in Podura Scale.*—Mr. T. F. Smith calls attention to what he considers to be a new appearance of the *Podura* scale not yet recorded. In place of the optician's appearance of the scale, with the exclamation marks, blue or red, according to the corrections of the glass, and with a light streak in the middle, more or less extended as the aperture is larger or smaller, the usual markings had vanished, and in their stead "the whole scale was studded with very slender spines with round heads, and the pointed ends stuck into the scale like a lot of pins stuck loosely and anyhow into a paper, and instead of being blue or red were a pure white." At first he thought there were two sides to the scale, and that this was the wrong one, but he found that the scale was tight against the cover, and that all the scales so placed had the same appearance.

Since then he has examined many scales on several slides, and is "now strongly of opinion that the note of exclamation markings are spurious, and that the light streak is the true appearance, which has hitherto been seen with the darker outline on each from taking too deep a focus. It is a well-known fact that an oil-immersion objective works only with its full aperture when an object mounted dry is well on the cover, and this in itself should be sufficient evidence that the appearance the object presents, under these circumstances, is the truer one. Then, again, the pin-like looking spines are not more than half the diameter of the exclamation marks, and the image is always at its smallest when in focus; never larger." Another fact which guides the author in his estimation of the structure is the observation of a hair with small projecting spines. "Here was structure of which there could be no doubt, and the same point of the correction-collar that gave the sharpest image of this hair gave also the sharpest image of the spines on the scale. Still another proof. To bring the note of exclamation marks out well requires a deal of management of the light, and they are best seen with the smallest apertures of the condenser; but no amount of light will obliterate the new ones or prevent them from standing out sharply from the general blaze."

"New Glass just made in Sweden."—We have received from a considerable number of correspondents cuttings from various newspapers describing this "new glass." As will be seen it is a revival of the paragraphs to which we called attention in the last volume of this Journal, pp. 155 and 321. What is the cause of this recrudescence we do not at all know, but it has apparently been disseminated all over England, as our cuttings come from London papers, local country papers, religious papers, &c.

The paragraphs are the most outrageous piece of rubbish ever published, and while of course editors can't be expected to know everything, they might surely get to know enough to avoid putting in such asinine statements as these.

"Perhaps the most wonderful thing that has been discovered of late

* Journ. Quek. Micr. Club, iii. (1888) pp. 203–4.

" is the new glass which hast just been made in Sweden. The revolution " which this new refractor is destined to make is almost inconceivable, if " it is true, as is positively alleged, that, while the highest power of an " old-fashioned microscopic lens reveals only the one four-hundred- " thousandth part of an inch, this new glass will enable us to distinguish " one two-hundred-and-four-million-seven-hundred-thousandth part of an " inch." *

" A new kind of glass, which is to revolutionize scientific investiga- " tion, has been invented in Sweden. Ordinary glass is composed of six " ingredients, but this compound contains no less than fourteen, chief " among the new substances employed being phosphorus and boron. For " microscopic purposes the power claimed for this Swedish glass is almost " incredible. One 400,000th of an inch can be distinguished by the " strongest lens at present, but the new glass will, it is said, reveal the " 204,700,000th part of an inch. If the Swedish invention at all ap- " proaches what is promised for it, its importance can hardly be exagger- " ated, but the very moderate performance of the so-called 'unbreakable " glass' invented a few years ago, may warn us to be somewhat sceptical " in regard to new wonders in the way of glass." †

Curiosities of the Senses.

["According to a memoir communicated to the Biological Society of Paris by M. Mathias Duval, and reported in the *Siècle*, it is not advantageous when looking through a telescope with one eye to close the other, but rather the contrary. We have not succeeded in verifying this observation with the Microscope."]

Scientif. News, I. (1888) p. 372.

Cz[apski, S.]—**Bemerkungen über Prof. Abbe's Abhandlung: Die Vergrösserung einer Linse oder eines Linsensystems.** (Remarks on Prof. Abbe's paper: The magnifying power of a lens or a lens-system.)

[Criticism of the papers of Prof. Abbe and Prof. Giltay in this Journal, 1884, p. 348, and 1885, p. 960.

" For practical microscopists to adopt Abbe's definition for ordinary use seems to me not only purposeless, but at no time desirable. On the other hand, for scientific purposes in theoretical discussions relating to the magnifying power of an optical apparatus, the stricter definition of Abbe will be of value; and even in Giltay's point of view, the number which represents the magnifying power is subjective, and applies only to an eye which sees an object best at the distance of 25 cm., but is different for another length of vision. The arbitrary character of the measure which Giltay raises as an objection to Abbe cannot be supported as an argument against his definition, for it is common to all magnitudes expressed in so-called absolute units.]

Zeitschr. f. Instrumentenk., VIII. (1888) pp. 104–5.

D., M. T.—Microscopical Drawings.

[Device for drawing with the Microscope:—" Take a small portion of the silvering from the back of a mirror, about 1/16 in. in diameter (there must be a thick coating of paint on the back of the amalgam to support it, or it will not break off). This small reflector is to be mounted with cement on the edge of a piece of watch-spring at the proper angle. The spring is bent round and fixed to a brass tube fitting over the eye-piece, so that the reflector stands about 1/4 in. from the eye-lens and central with it. On looking into it the object on the stage of the Microscope is seen, and appears to be projected on to the paper spread below. I believe that steel mirrors are used for the same purpose; but the amalgam has a very good surface, costs nothing, and can be renewed in a very short time. It is better than the 'neutral glass plate.'"]

Engl. Mech., XLVII. (1888) p. 170.

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* Essex local paper. † Christian World, 1888, April 19.

HODGKINSON, A.—**On the Diffraction of Microscopic Objects in Relation to the Resolving Power of Objectives.**
Proc. Manch. Lit. and Phil. Soc., XXV. (1886) pp. 263–7 (5 figs.) and pp. 223 and 271–2.

JAMES, F. L.—**Nobert's Bands.**
St. Louis Med. and Surg. Journ., LIV. (1888) pp. 166–7.

L., A. S.—**Powers of Eye-pieces.**
["Table of the powers of the eye-pieces of different makers as deduced from the total magnification with the 1 in. objective."]
Engl. Mech., XLVII. (1888) p. 146.

QUEEN, J. W.—**Apparent and Actual Size of Field, Magnifying Power, &c.**
Queen's Micr. Bulletin, V. (1888) pp. 1–2.

„ „ **General Hints on the use and care of the Microscope.**
The Microscope, VIII. (1888) pp. 4–5.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances.** XXXV., XXXVI.
[Researches in High Power Definition. Interference lines, circles, and dots. Attenuated lines, circles and dots.]
Engl. Mech., XLVII. (1888) pp. 137 (2 figs.), 226–7 (2 figs.).

WIENER, O.—**[Measuring Thin Films.]**
["In an exhaustive paper upon methods of measuring thin films, Otto Wiener makes certain measurements of the thickness of a film of silver which can just be perceived by the eye, and arrives at the conclusion that 0·2 millionths of a millimetre is an upper limit of the diameter of a silver molecule."]
The Microscope, VIII. (1888) p. 93, from *Scientific American*.

ZECH, P.—**Elementare Behandlung von Linsensystemen.** (Elementary treatment of lens-systems.) 8vo, Tübingen, 1887.

(6) Miscellaneous.

Heather's 'Mathematical Instruments.'—It is really a disgrace to all concerned—publishers and editor—that this book with a title-page of 1888,* should have been published.

It is inconceivable that any intelligent grown-up person should not have known that the extracts we print below are an anachronism in this year 1888 or even in the year 1848. Imagine, for instance, describing any Microscope of this date as having the "amplifying lens" of the old makers.

"The compound or achromatic Microscope consists of four lenses and a diaphragm, placed in the following order: the object-lens, the diaphragm, the amplifying lens, so-called because it amplifies or enlarges the field of view, the field-lens, and the eye-lens. The relations between the focal lengths and intervals of the lenses, and the distance of the diaphragm from the object-lenses are determined so that the combination may be achromatic, aplanatic, and free from spherical confusion. The field-lens and eye-lens form what is called the eye-piece, and the object-lens and amplifying-lens form, or tend to form, an enlarged image of the object in the focus of the eye-piece, which image is viewed through the eye-piece" (p. 79).

The following paragraph is also deserving of note:—

"The best Microscopes are constructed with compound object-lenses, which are both achromatic and aplanatic, and by this means the aperture, and consequently the quantity of light, is much increased. Good compound lenses possessing the required properties have been formed of a concave lens of flint glass placed between two convex lenses, one of crown glass and the other of Dutch plate" (p. 79).

* Heather, J. F., 'A Treatise on Mathematical Instruments, their construction, adjustment, testing, and use concisely explained.' 14th ed., revised, with additions by A. T. Walmisley. 8vo, London, 1888.

The above is followed by a whole page on "the Reflecting Microscope," no such a Microscope having been made certainly since 1840.

Micromillimetre.*—Prof. A. W. Rücker observing that the word micromillimetre is used as equivalent to the *thousandth* of a millimetre, and being told that it is now commonly employed by biologists, and especially by botanists, with that meaning, protests against such a use of the word.

As he thinks it would be very unfortunate if the same word were habitually used in different senses by students of different branches of science, he points out that, according to the definitions of the C.G.S. system, a micromillimetre is the *millionth* of a millimetre.

In the well-known report of the Committee of the British Association for the "Selection and Nomenclature of Dynamical and Electrical Units," it is laid down that the prefixes *mega* and *micro* are to be employed "for multiplication and division by a million." This ruling has been generally accepted not only by scientific men, but also by those engaged in commerce. Megohm and microfarad are terms which are used in contracts, and are universally understood to mean a million ohms and a millionth of a farad respectively. It will be hopeless, he thinks, to try to introduce scientific systems of measurement into the affairs of daily life if scientific men themselves disregard the rules on which those systems are framed.

It would also, in his view, be particularly confusing if the micromillimetre were wrongly used by microscopists. In its proper sense it is the most convenient unit in which to express molecular magnitudes. It has been employed for that purpose by Sir William Thomson and others in England, and also by physicists abroad. If the micromillimetre of the microscopist is 1000 times too large, all sorts of mistakes will be rife as to the relative dimensions of molecules and of the smallest objects visible with the Microscope.

The proper name for the thousandth of a millimetre (μ) is, in his view, the *micromètre*, and though the similarity of this word to *micromĕter* is no doubt a drawback, it is not likely that confusion could often arise between them. He therefore begs respectfully to suggest that botanists should bring their nomenclature of units of length into conformity with the definitions of the C.G.S. system. Otherwise there will be a permanent confusion between the micrometre (μ) and the micromillimetre ($\mu\mu$).

On the other hand, Mr. H. J. Chaney suggests† "that even the denomination 'micromētre' may be hardly acceptable to scientific workers. The denomination for the measure of the one-thousandth of a millimetre (μ), or 0·000001 metre, is 'micron,' and not 'micromētre.'

"For the 'micron' we have the authority of the 'Comité International des Poids et Mesures.' One shudders at the thought of the confusion likely to arise when computers are required to deal with both micromētre-units and micromĕter-divisions.

"The Comité International have also recommended the use of the following metric denominations for minute measurements:—

Denomination.	Symbol.	Equivalent.
Micron	μ	0·001 millimetre.
Microgramme ..	γ	0·001 milligramme.
Millilitre	ml.	0·001 litre.
Microlitre	λ	0·000001 litre."

* Nature, xxxvii. (1888) pp. 388-9. † Ibid., p. 438.

Mr. A. D'Abbadie also writes* to say that "here" (presumably Paris), *micron* is currently used to express the 1/1000 mm.; while Mr. R. B. Hayward proposes† a new nomenclature which would convert the micro-millimetre into a "hexametret."

The Council of the Society having considered the question raised by Prof. Rücker, decided, as announced at the April Meeting, that the term micron should in future be used in this Journal and in the official proceedings of the Society, in place of micro-millimetre. It was felt that the term micrometre from its similarity to micrometer (especially in French) was unsuitable.

American Society of Microscopists.—Columbus, Ohio, Meeting, 1888.
The Microscope, VIII. (1888) pp. 117–8.

Bond, G. M. (Editor).—**Standards of Length and their practical application.** A résumé covering the methods employed for the production of standard gauges to insure uniformity and interchangeability in every department of manufactures, including the reports of Prof. W. A. Rogers; the Committee on Standards and Gauges, American Society of Mechanical Engineers; the Committee of the Master Car-Builders' Association; and including also the Report of the Special Committee appointed by the Franklin Institute, April 1864.
[Describes and figures the Rogers-Bond Universal Comparator.]
iv. and 180 pp. and 31 figs., 8vo, Hartford, Conn., U.S.A., 1887.

Calcutta Microscopical Society. *The Microscope*, VIII. (1888) pp. 89–90.

Dallinger, W. H.—**Least and simplest forms of Life.**
[Three lectures at the Royal Institution.]
Scientif. News, I. (1888) pp. 282, 306, 378.

East London Microscopical Society.
[Report of meeting.] *Engl. Mech.*, XLVII. (1888) p. 142.

Michael, A. D.—**Parasitism.**
[Presidential Address to Quekett Microscopical Club.]
Journ. Quek. Micr. Club, III. (1888) pp. 208–24.

M'Intire, S. J.—**The Quekett Microscopical Club.**
[Report on soirée of 9th March.] *Sci.-Gossip*, 1888, p. 92.

Postal Microscopical Society.
[Suggestion for the formation of "circles" for "work either of a general or a specific character."]
Journ. of Micr., I. (1888) pp. 118–20.

Quimby, B. F.—**[Widening the Scope of Microscopical Societies.]**
The Microscope, VIII. (1888) pp. 125–6.

Schröder, H.—**Aufforderung der Gründung eines Instituts, um die grossen Entdeckungen der neuesten Zeit in der Astronomie, Astrophysik, Optik und Mikroskopie Allen zugänglich zu machen.** (Suggestion for the establishment of an Institute to make accessible to all the great discoveries of recent times in Astronomy, Astronomical Physics, Optics, and Microscopy.)
Central-Ztg. f. Optik u. Mech., IX. (1888) pp. 85–9 (5 figs.).

β. Technique.‡

(1) Collecting Objects, including Culture Processes.

Alkaline Egg-albumen as a Medium for Bacteria Cultivation.§ — Dr. J. Tarchanoff and Dr. Kolessnikoff find that if hens' eggs with their shells be placed in 5 to 10 per cent. solution of hydrate of potash for

* Nature, xxxvii. (1888) p. 438. † Ibid., pp. 437–8.

‡ This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

§ Russkaja Medicina, No. 11, 1887, p. 191. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 405–6.

from four to fourteen days, the albumen undergoes a change of consistence. By the fourth day it is fluid and transparent; from the fifth to the fourteenth it is transparent but firm, gelatinous and yellowish. Both modifications can be produced in a steam sterilizer either alone or in combination with gelatin (3 to 10 per cent. half-fluid) or agar agar (1 per cent. firm). For testing the utility of this medium for cultivation purposes the author's three combinations of alkali albuminate were (1) Bouillon albuminate: Albumen of eggs having lain four days in 10 per cent. KHO solution, and water added to make a 10 per cent. solution which was steam sterilized in the usual way for three days, and then put in test-tubes or Pasteur's "Matras" and again sterilized. (2) Syrup alkali albuminate: Albumen having been four days in KHO was diluted one-half with water, placed in test-tubes, and sterilized in the usual way. (3) Firm albuminate (*a*) Sterilized: Half-fluid albumen of four days' standing was poured in test-tubes and steam sterilized at 105° for some minutes to one hour on one or three days. It resulted that albumen after fifteen minutes' sterilization became opalescent-whitish, but was always transparent. On repeated or protracted sterilization it hardened and became of a yellowish-orange colour. (*b*) Unsterilized: Hard transparent hen's egg albumen of fourteen days' standing in 10 per cent. KHO was cut up into thin plates and treated like potato cultivations. On these three media various bacteria were sown. *Bacillus anthracis* grew very well on the bouillon albuminate; on No. 2 and 3 it was slower in starting. The cultivations were all pathogenic. *Spirochæte choleræ asiaticæ* and Prior-Finkler grew just as well as on their ordinary media. Although the latter fluidified No. 2 and No. 3 albuminates, the colonies were not characteristic. *Bacillus tuberculosis* and *Mallei* grew well, as did also *Bacillus subtilis*, *prodigiosus*, *Micrococcus ruber* Flügge, *Sarcina flava*, and orange. The authors lay stress on the simplicity of the production, the transparency and the cultural utility of this new medium for the most different kinds of bacteria. They anticipate that it will eventually supplant the ordinary gelatin, agar, and serum media.

Fatty Matters in Cultivation Media.*—Sig. L. Manfredi reports his experiments with cultivation media containing fatty matters.

The results were that whenever the fatty constituent (as in broths) reached one-third of the total amount, the bacillus of anthrax failed to thrive, and that when it passed that proportion, the cultivation became exceedingly feeble, totally ceasing before two-thirds was reached. This is given as a matter of precaution to those who experiment with fatty broths, &c. It has, however, a value beyond this, viz. that with the decreasing vitality of the specific microbes, their virus is attenuated, and that, consequently, by using a certain amount of fatty matter in the pure cultures, the virus may be correspondingly attenuated.

Collecting Microscopic Algæ.

["Take waxed paper (from cakes of soap, &c.), and punch holes slightly smaller than the largest covers; then wrap the paper about the slides in such a way as to bring the holes in the middle on each slide. On suspending the slides good mounts can be obtained. Surround it with a ring, place on another slip or cover-glass, and it is ready for observation."]

Scientif. Enquirer, II. (1888) p. 68.

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* St. Louis Med. and Surg. Journ., liv. (1888) p. 97, from Giorn. Internat.

Eyre, J.—**Pond Dredging and Collecting.**

[For more delicate work or for use in ponds, &c., comparatively free from weeds, a large-sized test-tube might be substituted for the bottle, and should be fastened to a short thin length of bamboo as follows:—"Take a 6 in. length of caoutchouc tubing, and make a cross cut three-quarters through, at about an inch from one end; then another at right angles to the first along the other 5 inches; the result is a short piece of tube with a 5 in. slip of gutta-percha. The tube is slipped over the end of the rod, and the free end of the flap is pushed between the rod and the tubing, the test-tube placed in the loop so formed, and the strip drawn tight and fastened off."]

Sci.-Gossip, 1888, p. 69.

Rousselet, C.—**Pond Dredging and Collecting.**

["Hints on collecting Infusoria, Rotifera, and Polyzoa, the result of my experience in this interesting pursuit."]

Sci.-Gossip, 1888, pp. 54-5.

(2) Preparing Objects.

Demonstrating Nuclein and Plastin.*—Dr. E. Zacharias in discussing the properties and mode of origin of nuclein and plastin, remarks that both substances are undissolved when the cells are treated with artificial gastric juice. Under the action of gastric juice, or of 0·2–0·3 per cent. hydrochloric acid, parts containing nuclein present a sharply defined appearance, while bodies which contain plastin but no nuclein swell up and grow pale. Nuclein swells up in 10 per cent. salt solution, in solution of soda and in dilute caustic potash. Plastin, on the contrary, does not swell up in 10 per cent. salt solution, and is only soluble with difficulty in alkalies. Both are soluble in concentrated hydrochloric acid, but in a mixture of 4 vols. HCl to 3 vols. H_2O the nuclein only disappears. When fresh, bodies containing nuclein swell up in distilled water. Long preservation in spirit is detrimental to these reactions. Nuclein takes up pigments with avidity, but this property is in no way confined to parts containing nuclein. All the cell protoplasm becomes stained by the prolonged action of pigment. It cannot therefore be concluded that nuclein is present because the nucleus becomes stained, but if it do not, it may be inferred that it is absent or present in small quantity.

Substances with the foregoing properties have hitherto only been demonstrated in the cell-nuclei; plastin, on the other hand, is a constituent of the whole cell-plasma. The existence of nuclein in bottom yeast, in Phycochromaceæ, milk, and yolk-corpuscles of animal ova appears to clash with the former statement. In the two last cases the substance in question differs in its reactions from nuclein. The author found it both in germinating and in bottom yeast. By extracting germinating yeast with ether alcohol, then soaking in water, and staining with Grenacher's hæmatoxylin, the cell-nuclei are rendered evident. The action of the digestion-fluid failed to demonstrate the nucleus; but in bottom yeast the nucleus was found to contain nuclein. Bottom yeast extracted with alcohol ether, digested, and then placed in a 0·3 per cent. salt solution for 24 hours, showed in the bright swollen-up plasma residue corpuscles of irregular shape, and with the characteristic brightness of nuclein. By adding pure strong hydrochloric acid the corpuscles lose the brightness, the plasma becomes clearer, and then disappears along with the corpuscles. A 10 per cent. salt solution acting on digested material which has been extracted with alcohol-ether causes the corpuscles to swell up while the rest of the plasma remains well defined

* Bot. Ztg., xlv. (1887) pp. 282–8, 297–304, 313–9, 329–37, 345–56, 361–72, 377–88 (1 pl.).

and unswollen. In Phycochromaceæ the nucleus was demonstrated in *Tolypothrix*, *Ægagropila*, and *Oscillaria* sp.; it was best shown by digesting the fresh filament, then extracting with ether-alcohol and examining in a 0·3 per cent. salt solution. The author also treats of the resting and active condition of the nucleus, and the cells taking part in reproduction.

Preparation of Nerve-cells and Peripheral Ganglia.*—Anna Kotlarewsky employed in her researches on the spinal ganglia, and on the Gasserian ganglion four different hardening methods. (1) Hardening in acids: 3 per cent. nitric acid; half per cent. chromic acid; 1 per cent. osmic acid; 1 per cent. picric acid, and Flemming's mixture. The preparations were imbedded in celloidin, or paraffin. Next to freshly examined cells, the picric acid was found to produce the best effect. Flemming's mixture had an unfavourable action on the shape of the cells. In all the preparations hardened in acids, the outline of the cells was sharp; the cell-body took stains well, but the nucleus only slightly, though the nucleoli were well coloured. (2) Hardening in acid salts (Müller's solution). (3) Hardening in neutral media (neutral acetate of lead and spirit): Cells in the preparations treated with 10 per cent. solution of acetate of lead showed excellent fixation; hardening in spirit was less favourable. (4) Hardening in alkaline media: Basic acetate of lead and ammoniacal chloride of silver (1 per cent.) were used. Both solutions penetrated only slowly, so that the superficial layers could be used. The depth to which the hardening medium had penetrated was determined by treating the sections with hydric sulphide or bichromate of potash.

The hardened objects were variously stained. (1) With metals: Osmic acid used for preparations hardened in Müller's fluid effected no remarkable differentiation of the nervous elements. After-treatment with ammoniacal silver solution (reduction being effected in an incubator) gave a better result. In this way good pictures were obtained in 24 hours; the preparations, however, did not keep. (2) With nuclear stains: these affected the bodies of the nerve-cells more than the nuclei, the corpuscles in the latter behaving in a way similar to the cell-body. Gentian-violet and hæmatoxylin stained the granula of the body of the cell; carmine in neutral solution did not. Merkel's staining method gave favourable results for differentiating the chromophilous and chromophobous cells. (3) Dyes were used which do not stain the nucleus; eosin, fuchsin, nigrosin. Of these, nigrosin produced in the lead preparations interesting pictures, the dye having stained the protoplasm, a reticulated appearance was imparted to the cell-body. In the lead preparations, eosin stained the nucleus pretty dark, and the cell-body of the nerve-cells diffusely. Methylen-blue was examined by dissolving it in 0·7 per cent. salt solution, and injecting it into the spinal lymph-sac or abdominal cavity of a frog. Some time after the injection the ganglia were removed as quickly as possible, and examined in salt solution or glycerin. The cells were stained in about one or two hours.

Methæmoglobin Crystals.†—According to Dr. W. D. Halliburton the following is an easy way to obtain these crystals:—

Defibrinate a few cubic centimetres of the blood of a rat, guinea-pig,

* MT. Naturf. Gesell. Bern, 1887, pp. 3-23.

† St. Louis Med. and Surg. Journ., liv. (1888) p. 96.

or squirrel, and add to it a few drops of amyl nitrite and shake violently for a minute or two, or until the nitrite assumes a chocolate colour. A drop of this is withdrawn with a pipette, and placed on a slide, the cover-glass being applied immediately. In a few moments the methæmoglobin crystals will begin to form. By sealing the edge of the cover-glass, the crystals will remain unchanged a very long time.

Preparation of Brains and other Organs.*—Prof. M. Flesch prepares brains for permanent preservation in the dry condition in the following simple manner:—

After having been hardened in spirit, the preparations are first placed in a mixture of equal parts of glycerin, alcohol, and water, and afterwards into pure glycerin. To both fluids sublimate is added in the proportion of 1 to 3000. Bone and cartilage may, without previous hardening, be placed in the first solution and then changed to the second. The time of the treatment depends on the size of the object. A human brain should lie about four weeks in spirit (if placed upon cotton-wool 10–12 cm. thick, it is not necessary to change the spirit, nor to turn the brain so often), then for three weeks in each of the two solutions. The rest of the treatment consists in removing the superfluous glycerin by placing the specimens to drain upon a layer of blotting-paper supported on cotton-wool, and they are finally put up in a similar way and covered over with a glass-topped cardboard case. The cost of the method is small, since both solutions can be used repeatedly.

Preparing Radulæ of small species of Gastropoda.†—Mr. C. E. Beecher kills the organisms by boiling or immersion in alcohol, and then extracts the animals from their shells by drawing them out with a mounted needle or hook, and, in the larger species the head is cut off and the remainder of the animal rejected. In the minute species the shell may be removed with hydrochloric acid. Either process may be employed upon shells which contain the dried remains of the animals.

The specimens are then placed in a small porcelain crucible containing water in a sand-bath over a Bunsen burner. After boiling a short while, a small piece of caustic potash is added and the boiling continued until the tissues have become disintegrated. The boiling is then stopped to prevent the thin membrane upon which the lingual teeth are situated from being attacked. After removal from the burner, water is added, and the undissolved material allowed to precipitate. The fluid is then removed by means of a pipette, or by decantation, and fresh water added, and this last procedure repeated until the potash and light flocculent material are eliminated. The residue is then washed in a flat-bottomed dish or large watch-crystal, and the radulæ removed on needles to a vessel containing a small amount of water. In case the radulæ are very small, the material is transferred drop by drop with a pipette, and examined under a 1-inch objective; the Microscope should be furnished with an erector. The radulæ are thus easily detected and removed.

A drop of strong chromic acid is added to the specimens, and in from one to two minutes the teeth on the radulæ are stained a light yellow or amber colour. After washing out the chromic acid, the specimens are dehydrated in the usual way, and after removing the alcohol with a

* MT. Naturforsch. Gesell. Bern, 1887, pp. xiii.–xiv.
† Journ. New York Micr. Soc., iv. (1888) pp. 7–11.

pipette, absorbent paper, and partial evaporation, oil of cloves is added, and the specimen mounted in balsam. The lingual membranes will be found more or less coiled, and usually attached to the jaws. It is desirable to have the membrane flattened out, with the dentiferous side uppermost, and dissociated from the jaws. Some species have a large strong jaw, which, if left with the lingual membrane, will raise the cover so far above the denticles as to prevent the use of high powers. It is therefore necessary to unfold the radula and remove the jaw. Having provided a clean glass slide on the turntable, the specimen is taken from the clove oil and centered on the slide. The radula is then easily unrolled with needles under a Microscope provided with an erector, and the jaw removed. Replaced on the turntable, a thin cover-glass is imposed and centered. This should be done before the balsam is added, as it prevents the specimen from again becoming coiled or displaced. A drop of balsam in benzol is put adjacent to the edge of the cover, and the slide held an instant over a gas-burner or spirit-lamp, which will cause the balsam to flow under the cover. A spring clip is then put on to fix the cover down. The slide is next removed to an oven and left until the balsam has hardened, so that the portion outside the cover can be scraped off. The slide is then cleaned by washing in strong spirit, and dried with soft tissue paper. The cover-glasses should be of known thickness. Many radulæ require a 1/10 in. objective. The convexity of the object, combined with the thickness of the cover, necessitates the use of very thin glass. For the Rissoiidæ the author usually employs glass of 0·004 in. thickness.

Some good preparations were obtained by using nitrate of silver instead of chromic acid as a staining reagent, but the specimens require boiling in the silver solution, and this additional step further complicates the process and makes it less possible to retain small specimens. Besides, too much action of the silver renders the objects opaque.

Preparation of Cypridinæ.*—Dr. A. Garbini examined fresh teased-out tissue in sea water. Maceration was effected in a small quantity of one-third spirit. The best fixative was found to be a watery solution of sublimate. In this the animals were left for 5 to 7 minutes, and then transferred to distilled water, and afterwards to 75 per cent. alcohol, with a trace of tincture of iodine, and finally to pure 75 per cent. alcohol. Good results were obtained from Mayer's fluid (Kleinenberg's mixture with sulphuric acid), but the epithelium of the digestive tract was less well fixed. The preparations were imbedded in paraffin by Giesbrecht's method.

Preparing Ova of Ascaris megalocephala.†—Prof. E. van Beneden, in his further researches on the ova of *Ascaris megalocephala*, treated the fresh ova with glacial acetic acid or with an equal mixture of crystallizable acetic acid and absolute alcohol. After twenty minutes, when fixing had taken place, the acid was replaced by a third part of glycerin in water, and by aqueous solution of malachite-green, or of vesuvin, or of both together. The staining soon takes place, and if it be allowed to go too far can be readily washed out. If glycerin be rapidly substituted after five or ten minutes, the ova although stained will go on segmenting, and even form normal embryos.

* Bull. Soc. Entomol. Ital., xix. (1887) pp. 35–51 (5 pls.).

† Bull. Acad. R. Sci. Belg., xiv. (1887) pp. 215–24 (2 pls.). *Supra*, p. 423.

Mode of Investigating Echinorhynchi.*—Dr. R. Koehler finds that the tissues of *Echinorhynchi* can be well fixed by the employment of a sublimate solution acidified to saturation by acetic acid (Roulle's liquid). This reagent has the advantage over osmic acid of not producing after-coloration, and as animals generally die in it without contraction it is additionally useful. The fixation of the internal organs is complete ten minutes or a quarter of an hour after immersion. He did not find any difficulty, such as was experienced by Saeftigen, in staining the tissues, though the coloration is a little slower than usual. Any want of success is due to trying staining *en masse*, for the cuticle is difficult to penetrate; there is no difficulty with sections. Kleinenberg's hæmatoxylin is to be recommended. Anilin dyes, such as coccéinin and "rouge de Bordeaux R," give very fine stains, and the latter was found good for all kinds of tissues, and in very weak solutions, applied for some hours, gave good colorations to pieces of *Echinorhynchus heruca*. With *E. gigas* coloration *en masse* is easy if the cuticle be removed, as can easily be done.

Preparing the Nervous System of Opheliaceæ.†—Dr. W. Kükenthal places the Annelida to be examined in a mixture of chloral hydrate and sea water (1 : 1000), or adds a little spirit to the sea water. The animals are thus benumbed without contraction or laceration, and afterwards killed in 70 per cent. spirit or sublimate. Lang's mixture hot or cold, 1 per cent. chromic acid, osmic acid, picrosulphuric acid, Müller's fluid, iodine alcohol, and Merkel's fluid were used for the same purpose.

The author's method for producing nerve-preparations is as follows :—(1) The fresh animals were cut up along their back, placed in a basin, and covered over with 10 per cent. nitric acid, which was allowed to act for ten or twelve days. They were then well washed with distilled water, and then immersed for fifteen minutes in a 1 per cent. solution of gold chloride, to which one drop of hydrochloric acid was added. They were again washed in distilled water and placed in 5 per cent. formic acid for twenty-four hours. Then frequent washing with distilled water, removal of the intestinal tract and of the muscles by means of a fine brush and a stream of water. Then spirit, turpentine, Canada balsam. (2) The animals were slowly killed in sea water plus a little Merkel's solution, spread out in a basin, and covered over with pure Merkel's fluid. After twenty-four hours they were washed and transferred to weak spirit, stained with Grenacher's borax-carmine, then decolorised with hydrochloric acid alcohol, and after absolute alcohol and turpentine, mounted in Canada balsam. (3) (According to the author very suitable for material long in spirit). The animals were cut up and spread out in a basin and immersed in 1 per cent. osmic acid for twelve to eighteen hours. They were then washed, stained with hæmatoxylin, and mounted in Canada balsam. The simplest and best method for cutting is as follows:—The animals hardened in 70 per cent. spirit are stained with Grenacher's borax-carmine, then treated successively with acidulated acohol, absolute alcohol, chloroform, and finally imbedded in paraffin. The sections are stuck on with collodium-clove oil, followed by turpentine oil, to which a few drops of picric acid are added. Then methyl-green, turpentine oil, pure turpentine, Canada balsam. The nuclei are red, the plasma and intercellular substance green, the nervous

* Journ. de l'Anat. et de Physiol., xxiii. (1887) pp. 614-5.
† Jenaisch. Zeitschr. f. Naturwiss., xx. (1887) pp. 511–80 (3 pls.).

tissue yellow and well defined. Animals preserved in spirit may be placed for twelve to eighteen hours in 1 per cent. osmic acid, and after being well washed stained with hæmatoxylin.

Preparation of Echinodermata.*—Dr. O. Hamann preserves the organs of Echinodermata in Flemming's chromo-osmium acetic acid. For preserving and decalcifying small animals chromic acid was used; animals preserved in strong spirit were afterwards decalcified by immersion in a 0·3 per cent. solution. After having been washed for twelve hours they were stained with hæmatoxylin. For examining the anal blood-lacunæ, the sea urchin is well hardened in spirit, the anal parts are decalcified in 1 : 400 chromic acid, and stained with a neutral carmine solution. Decalcification in hydrochloric acid or in chromo-nitric acid is less satisfactory, as the tissues are more affected. The pedicellaria can be cut without being decalcified, and after being carefully washed, stained with carmine or logwood.

For examining the glandular organ, the so-called heart, treatment with the anilin dyes (safranin, methyl-green, anilin-green) was found to be advantageous. Excellent preparations of organs of *Sphærechinus granularis*, hardened in a 1/2 per cent. chromic acid, were obtained by staining the sections with Schiefferdecker's anilin-green, absolute alcohol, bergamot oil or xylol, paraffin, xylol, xylol-balsam. The author prefers xylol to turpentine, chloroform, and oil of cloves.

Methods of Fixing and Preserving Animal Tissues.†—The present systems of fixation may be resolved, says Dr. N. Kultschizky, into three :—(1) The chromic acid salts of potassium and ammonia and mixtures of those with other salts (Müller's and Erlicki's fluids) fix histological objects well, but this method, according to Prof. Flemming, is not suitable for examining the process of karyokinesis. Prof. Virchow has, however, recently stated that the deficiencies of chromic acid salts may be obviated if they be dissolved in spirit in the dark. (2) The second group of fixatives consists of chromic acid, osmic acid, picric acid, acetic acid, &c., and includes the mixtures of Flemming, Kleinenberg, Fol, and others. This group, particularly the Flemming's mixture, is especially valuable for demonstrating the division of the nucleus. Chromic acid, it must be remembered, almost always produces an insoluble precipitate of albumen, and consequently is deceptive, from calling into existence a tissue-like structure and for forming insoluble and impermeable combinations, as, for example, in objects with a muscular tissue. (3) The best fixative of all is alcohol, but, as it has a great attraction for the watery element of albumen, it produces considerable alteration in the form of objects.

Hence, as none of the three foregoing methods are perfect, the author has found it advisable to pursue the following course, which includes the least defective points of all three.

The fixative is prepared by mixing excess of finely powdered bichromate of potash and sulphate of copper in weak spirit (50°), and allowing them to stand in complete darkness for twenty-four hours. A greenish-yellow fluid is hereby obtained, and this, before being used, is acidulated with acetic acid (five or six drops to 100 ccm.).

The object to be fixed is placed in the fluid prepared as above for twelve

* Jenaisch. Zeitschr. f. Naturwiss., xxi. (1887) pp. 87–266 (13 pls. and 2 figs.).
† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 345–9.

to twenty-four hours, according to its size and the degree of hardness required. The whole transaction must be carried out in the dark, otherwise the salts will be precipitated. The objects are then placed in strong spirit for twelve to twenty-four hours, after which they may be sectioned in any of the usual ways. With regard to the preservation of material the author rejects alcohol and chromic acid and its salts on account of the changes induced by these reagents, and advises ether, xylol, toluol, or any substance which does not act upon albuminous matter.

Isolating Lower Algæ.* — The isolation of some Chytridiaceæ, Saprolegniæ, and monads from different waters is easily effected by catching them with the aid of pollen-grains, fern-spores, or fungi spores which are disseminated in the water and then allowing them to develope until they fructify. For this purpose, says Dr. W. Zopf, the pollen-grains of Coniferæ are very suitable. By this method *Lagenidium pygmæum*, *Rhizophidium pollinis*, and *Olpidium luxurians* can be isolated with almost unfailing certainty. Under favourable circumstances algæ with sporangia can often be obtained in 15 to 30 hours after depositing the pollen-grains.

Curtis, C.—**The Tapeworm: methods of preparation.**

[Reports finding in Trans. Linn. Soc., II. 1794, a paper by A. Carlisle, which presents the same methods and elucidates the same fact regarding the valves" as the paper of J. M. Stedman, *ante*, p. 148.]

The Microscope, VIII. (1888) pp. 102–4.

Entomologists, Young, Microscopic Work for.

["A few simple directions to the beginner who wants to know how to mount the hard parts of common insects."]

Scientif. News, I. (1888) p. 316.

Latham, V. A.—**To prepare the Head of a Flea. Mounting Tongues of Flies.**

Scientif. Enquirer, III. (1888) pp. 10 and 13.

" " **Preparing Sections of Buds.**

["Take a small piece of a twig—say, linden—having a bud at its upper end; fix well in section-cutter, wet with alcohol, cut with a sharp knife into thin slices, keep flooding the knife with strong alcohol to keep the sections floating, and to keep them from falling apart. Do not let a drop of water touch the section, or it will cause it to fall to pieces. Now place in alcohol faintly coloured with iodine-green; let them remain for several hours until the colour disappears from the alcohol. Again put them into alcohol, this time coloured a little more deeply with eosin in place of green. Let them remain there till they are all pink. Then wash in two alcohols of 95 per cent., drop into clove oil for a few moments only, and mount in Canada balsam. They are thus very instructive."]

Scientif. Enquirer, III. (1888) p. 69.

Schwerdoff.—**Untersuchungsmethode frühzeitiger Studien der Entwickelung von Säugetiereiern.** (Method of investigation for the earlier stages of the development of mammalian ova.)

Arbeit. Versamml. Russ. Aerzte Moskau, I. (1887) 1/2 p. (Russian).

Van Gieson, J.—**A résumé of recent Technical Methods for the Nervous System.**

Journ. Nerv. and Met. Diseases, XIV. (1887) p. 310.

(3) Cutting, including Imbedding.

Imbedding Plant Tissues.—We referred at p. 680 of the last volume to Dr. S. Schönland's method of imbedding delicate plant tissues in paraffin, so that unshrunken serial sections may be cut by the ribbon method. The author then described the results which can be attained as almost incredible. In serial sections of leaves one can not infrequently

* Abh. Naturf. Gesellsch. Halle, xvii. (1887) 31 pp. (2 pls.).

obtain four to six sections through the same stoma, and it is easy to get several sections through the apical cell of a fern root when the imbedding is properly done.

Dr. Schönland now writes * that since the publication of his former article he has had the opportunity of gaining more experience in the use of the method, leading him to modify it slightly. In the first place he now uses absolute alcohol where he formerly only used the strong methylated spirit of commerce. Further, he now leaves specimens to be imbedded for 24 hours in pure oil of cloves (after they have sunk), 24 hours in pure turpentine, 24 hours in turpentine saturated with paraffin, and 24 hours in melted paraffin. Although much more time is thus required, the results are more reliable, and he can now imbed by his method without previous staining in borax-carmine, and thus considerable time and trouble are saved.

He adds that sections fixed to the slide with collodion stain very well with Bismarck brown, and can then easily be photographed. Bismarck brown † stains all cell-walls. If Kleinenberg's hæmatoxylin is used in addition, the cellulose walls turn blue, while all other walls retain their yellow colour, and thus a nice double stain is effected. If sections of young tissues are treated in this way, the process of lignification in vessels can be easily traced; and if the hæmatoxylin is allowed to act a sufficient time on the sections, the structure of the protoplasm will be brought out.

Celloidin-paraffin Methods of Imbedding.‡—Prof. J. A. Ryder calls attention to Kultschizky's method for imbedding in celloidin and paraffin, which method was noticed in this Journal, 1887, p. 845. He finds that it works admirably with specimens of injected spleen. The sections can be cut with a dry knife on any paraffin microtome. With the author's automatic microtome it is easy to cut sections 1/2000 in. in thickness with the greatest ease, since a ribbon forms more easily than even in the case of ordinary paraffin imbedding. The section-stretcher may be dispensed with entirely, so that for consecutive or embryological work the method is highly to be recommended. The author has modified the original method by substituting chloroform for origanum oil, as the latter is objectionable because it is disagreeable in odour, inflammable, darkens in a short time, and causes the object to shrink slightly. Beyond the substitution of chloroform for origanum oil there is no alteration in the details of the process.

In order to fasten the block containing the object in the holder, a heated wire is used, and to make the sections form a ribbon nicely, the hard paraffin used for the final imbedding may be mixed with soft paraffin or paraffin gum, melting at 45° C. This method enables thinner sections to be cut than with the usual wet celloidin process.

The sections may be mounted direct from the chloroform, but the operator must not allow the chloroform to evaporate before the section is covered with balsam. Another method of clearing the section is that proposed by Weigert, who uses a mixture of equal parts of xylol and

* Bot. Gazette, xiii. (1888) p. 61.

† The solution of Bismarck brown is prepared by saturating 1 part of absolute alcohol with Bismarck brown and adding 2 parts of distilled water. A solution in 70 per cent. alcohol, as often used by zoologists, does not stain lignified cell-walls very readily, and the solution in water hitherto used by botanists is said not to keep very well.

‡ Queen's Micr. Bulletin, iv. (1887) pp. 43–4.

pure carbolic acid. This liquid may be applied to sections on the slide by means of a camel's hair pencil, and will clear other sections instantly without in the least attacking the celloidin.

Pharmacognostic Microtome and Technique.*—Dr. E. Vinassa has recently made several improvements in the microtome adopted for pharmacological work and described in this Journal, 1886, p. 887.

In the first place the general construction has been so altered that it

FIG. 93.

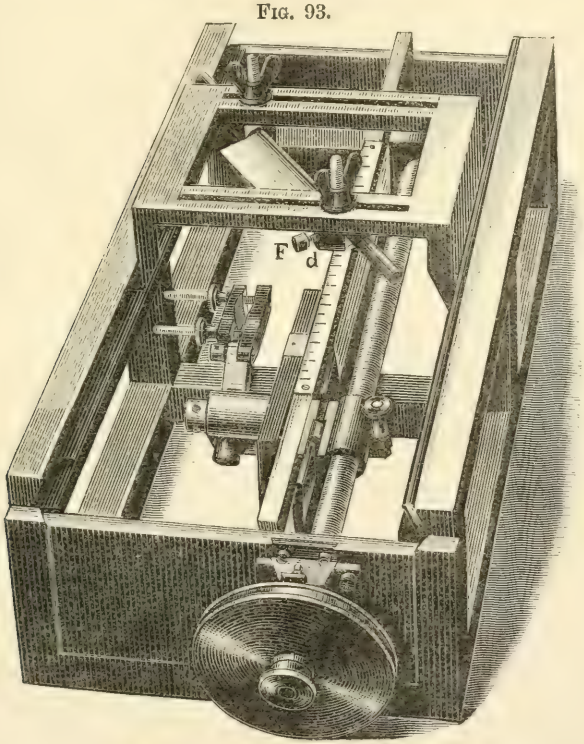

FIG. 94.

is now much broader, and therefore allows more play for the manipulation of the knife and object-carriers. The object-clamp has also been rendered firmer by a new device. This consists of a plate moved up and down by a long screw, and adjusted so that it supports the object-carrier while it in nowise impedes the play of the carrier about its various axes.

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 295–303 (3 figs.).

A further inconvenience, namely the too complicated arrangement for altering the horizontal position of the carrier, has been obviated.

The knife-handle now, instead of being flat, is made round so that it can be fixed in any position quite easily by means of the screw F (fig. 93). The handle passes through an iron block *d*, and is tightened up by means of the winged screws. The exact shape of the knife fitted with a handle for sharpening is shown in fig. 94. For cutting hard objects such as dense wood and bark, the author advises the knife to be ground like a plane.

After alluding to the advantage of using Jung's section-stretcher in connection with his microtome, the author passes on to the treatment of vegetable preparations. In a former communication the author advised the imbedding of roots, barks, and wood in glycerin jelly. But as the vacuum apparatus necessary for this procedure is not always available, he now occasionally resorts to the older methods of softening the preparations in spirit, glycerin, and water, and this is specially adapted to hard close-grained objects. Woods are always placed in glycerin and water, and can then be cut with an unwetted knife without tearing. If afterwards the sections are placed in glycerin to which some caustic soda has been added they are easily unrolled.

With regard to fruit and seeds of a hard consistence and structure, such as *Strychnos potatorum*, *S. nux vomica*, *Coffea arabica*, and the kernel of *Phœnix dactylifera*, preparations easy to be cut can be obtained in two or three days by softening the objects in dilute caustic soda or potash. But as any further microchemical examination is useless owing to the destruction of the alkaloids by the caustic alkalies it is preferable to soften the seeds by means of steam. This is done in a wide funnel into which a piece of wire gauze is placed as a sort of filter, and upon this the seeds. The funnel should be lined with filter paper to carry off the condensation water, and the funnel supported on a tripod in a water-bath. In 30 to 60 minutes the objects will be found sufficiently softened to cut quite regular sections from.

Some objects, such as almonds and cocoa-beans, crumble away under the action of the knife, and therefore require to be imbedded as they cannot be fixed directly in the jaws of the object-carrier. Glycerin gelatin is unsuitable for this purpose as the mass does not offer sufficient resistance, and although paraffin is usually unsuitable owing to its complicated manipulation it gives fair results by the following procedure. The seeds should be slightly warmed in order to drive off as much moisture as possible, and quickly immersed in paraffin only heated a few degrees above its setting point. They are then left to cool until a thick coating has developed upon them. In this way the paraffin will be found to have filled up all the chinks and crannies in the seeds, and not only offer sufficient resistance to the knife, but will also invest the sections with a sheath sufficiently strong to prevent their crumbling away. The paraffin is then dissolved out with benzin, ether, or chloroform, and the preparations mounted in glycerin jelly or in Canada balsam according to the special idiosyncrasies of the seeds.

Small seeds and fruits, such as those of the Solanaceæ and Umbelliferæ, should be imbedded in a paraffin of a high melting-point. Glycerin jelly, to which a little sublimate is added, is recommended for mounting permanently. Air-bubbles are easily got rid off by slightly warming the slide and then pressing on the cover-glass with a lead roller, 3 cm

long and 1 cm. in diameter. In a few hours the expressed jelly may be scraped off with a knife, the last traces being removed with lukewarm water. The slide is then cleared up with spirit and ringed round with some cement. Glycerin jelly not only possesses the clarifying property of glycerin, but all the other advantages of this medium.

HAENSELL, P.—**La Méthode de l'inclusion du Globe Oculaire dans la paraffine et dans la celloidine.** (Method of imbedding the eye in paraffin and celloidin.) *Bull. Clin. Nat. Ophthalm. Hôp. Quinze-Vingt*, IV. (1886) p. 154.

REYNOLDS, R. N.—**A new Planisher.** *The Microscope*, VIII. (1888) pp. 104–5 (4 figs.).

(4) Staining and Injecting.

Staining Living Preparations.*—Prof. M. Flesch is of opinion that living objects do not become stained by the ordinary methods, or do so in a way quite different from hardened preparations. Cyanin, for example, produces in the tissue-elements of the living organism different forms from those in which the same dye has been employed after fixation. What has stained in the dead preparation can never be similarly affected while alive. The parts which become stained show in many cases a great chemical activity, a lively power of reduction towards certain chemical compounds. One series of stains is only successful after previous treatment of the object with easily reducible metallic combinations. By control experiments it is seen that the staining extends just as far as the metallic precipitate. The original constituents of the tissues are not stained, but chemical products which result from the treatment with hardening agents. These might be metal albuminates or decomposition products arising from the chemical processes at the death of the living tissue, induced by the reduction processes. The result of a stain can only be judged from the chemical processes arising during fixation.

Staining Nerve-endings with Methylen-blue.†—Dr. C. Arnstein states that in frogs injected with methylen-blue the motor nerve-endings, Courvoisier's fibres, and the cells of the sympathetic are stained. In the freshly cut-out retina there is usually no stain, but this appears after the air has acted upon it. As a fixative, besides the iodine previously given, picrocarmine or picrate of ammonia may be used. The choice of the substance depends on whether a nuclear or diffuse stain is desired. Fixation by the last two methods is more lasting than when effected with iodine, though with the latter the nerves are deeply stained. Mammals and birds die too quickly after the injection of the methylen-blue for the method to be practically available, yet these animals, after they have been killed with chloroform, can be successfully injected through the heart or some large vessel. The pigment is used in a concentrated form, and the injection is suspended directly the resistance becomes marked. The organs first stained blue quickly become pale, and no nerve-staining is seen at first, but this occurs directly there is access of air to the preparation. The gradually occurring colour may be followed under the Microscope, and when it has attained its maximum some drops of a fixative medium may be added. In this way very perfect nerve-endings from the cornea, iris, and retina of mammals and birds have been

* MT. Naturforsch. Gesell. Bern, 1887, pp. xiv.–xv.
† Anat. Anzeig., ii. (1887) pp. 551–4.

obtained. Staining may also be effected on the slide if a nerve-end apparatus be spread out and a dilute solution of methyl-blue be added. Staining the retina of fish, birds, and mammals is more successful by this method than by injection. In other parts this method gave less favourable results.

Demonstrating Karyokinetic Figures.*—Dr. G. Martinotti and Dr. L. Resegotti proceed as follows to demonstrate karyokinetic figures.

The tissues are fixed with absolute alcohol. The sections are stained by leaving them five minutes in an aqueous solution of safranin and the stain is differentiated by transfering them to a spirit and water solution of chromic acid. This solution is prepared by mixing one part (by volume) of a watery solution of chromic acid (1:1000) with nine parts of absolute alcohol. In this very dilute solution the sections are left for a half or one minute, agitated therein, and then dehydrated in absolute alcohol, cleared up in bergamot oil, and mounted in dammar. In this way the chromatin filaments and the true nucleoli are stained a lively red, the protoplasm and the intercellular substance remain uncoloured, the resting nuclei are faintly stained a pale red.

The spirit and water solution of chromic acid should be prepared fresh every time. In some cases it is useful to employ a slightly stronger solution, that is, to mix two volumes of the watery solution of chromic acid (1:1000) with eight parts of absolute alcohol. At other times it is advantageous to dilute the watery solution of safranin with an equal volume of distilled water, and to leave the sections therein for five minutes, then keep them in the chromic acid solution until they have assumed a uniform rose tint.

The authors in conclusion remark that safranin seems to have a special affinity for the chromatin of the nucleus, that they have been unable to convince themselves that anilin oil is detrimental to nuclei in motion, and that oil of cloves, as previously noted by Bizzozero, extracts the anilin dyes more quickly from nuclei in repose than from those in mitosis.

Staining Membranes in Living Siphoneæ.†—Dr. F. Noll finds that in *Caulerpa prolifera*, some kinds of *Bryopsis* and *Derbesia*, and some Florideæ, the membranes become thickened by deposition of new layers. If the original membrane be stained without damaging the plant, it is seen that on further growth new unstained lamellæ are deposited upon the stained parts. The author coloured the membrane with Berlin or Turnbull's blue in the following way:—One part of sea water was diluted with two parts of sweet water, and in the mixture so much ferrocyanide of potash was dissolved as to give it the specific gravity of sea water. A second fluid consisted of two parts sea water and one part sweet water, and some drops of chloride of iron. This solution must be made fresh before each time of using. If Turnbull's blue were used the solutions were ferrocyanide of potash and lactate of iron. The deposition of Berlin blue was effected by removing the plants from sea water to the cyanide solution (1–3 seconds); they were then washed in sea water, and immersed for 1/2–2 seconds in the iron solution. The plants were next again removed for a moment to the ferrocyanide solution, and afterwards washed in much sea water. Care was always taken that the cyanide should be in excess in order that the iron chloride should never come in contact with the plasma as iron chloride. By

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 326–9.
† Bot. Ztg., xlv. (1887) pp. 473–82.

repeating the process a beautiful blue of any desired tone was easily imparted to the membrane. If the plant had not been damaged by the above treatment, the bluish colour disappeared in a few hours, the Berlin blue was decomposed, and the iron remained. By putting the plant in a solution of ferrocyanide of potash acidulated with hydrochloric acid, the blue could be restored to its original situation.

Roux's Colour-test for the detection of Gonococcus.*—Dr. E. C. Wendt's researches on gonococcus were merely intended to find a diagnostic criterion for gonorrhœa. He therefore examined other secretions as well, e.g. balanitis, otorrhœa, conjunctivitis, &c. Gonococci were found in all cases of gonorrhœa, but in other cases, even in the normal urethra, there were found diplococci indistinguishable from the gonorrhœa cocci. The criterion insisted on by Bumm, namely the intracellular arrangement of the gonococci about the nucleus, is found by the author to be not always correct, since it is not the case where blenorrhœa is passing away. The only certain characteristic, according to the author, is that from Roux's test, which depends on the fact that the gonorrhœa bacteria are able to retain anilin to a slight extent.

Acid Logwood Stain.†—An excellent acid logwood stain can, it is stated, be made as follows:—One part of a saturated solution of calcium chloride in proof spirit (alcohol of 50°) is added to eight parts of a similar solution of alum. Extract of logwood (the common commercial) is added to the mixture and agitated until it no longer dissolves freely. Let the container stand in a cool, quiet place for a few days, decant the clear liquid (which makes an excellent stain just as it is), and to every 100 parts add 80 parts of a 1 per cent. aqueous solution of acetic acid. Let stand for a day or two, and filter off into a glass-stoppered vial.

Alcoholic Alum-Carmine Stain.‡—Dr. W. C. Borden gives the following formula for producing a perfectly clear purplish-red fluid, superior to any aqueous alum-carmine stain in clearness and brilliancy of colouring. It will keep indefinitely, but a slight precipitate sometimes forms which should be filtered out. This does not indicate any decomposition of the stain, nor does it alter its staining character in any respect. Cochineal (whole insects), 1 dr.; saturated solution of alum, 4 oz.; 95 per cent. alcohol, 4 oz. Pulverize the cochineal in a mortar, add the saturated solution of alum, and boil for fifteen minutes, adding distilled water occasionally during the boiling to make up for the water lost by evaporation. Cool and pour without filtering into a ten-ounce or larger bottle. Add the alcohol and let stand, with occasional shaking, for forty-eight hours. Filter and preserve in a close-stoppered bottle.

The following stain made with carmine and without heat will give a fluid nearly identical with the first, except that no precipitate occurs, however long it be kept. Carmine, 30 gr.; alum, 4 dr.; distilled water, 4 oz.; 95 per cent. alcohol, 4 oz. Grind the carmine and alum together in a mortar, gradually adding the water. Add the spirit and pour without filtering into a ten-ounce bottle, cork tightly, and let stand for a week, shaking occasionally. Filter, and preserve in a close-stoppered bottle.

For staining in bulk, pieces of tissue may be transferred directly from strong spirit to either fluid, and may remain from two days to two weeks.

* Med. News, i. (1887) pp. 455–7.
† St. Louis Med. and Surg. Journ., liv. (1888) p. 165.
‡ The Microscope, viii. (1888) pp. 83–5.

Tissues hardened in alcohol or in corrosive sublimate and spirit stain more rapidly than those hardened in Müller's fluid or chromic acid. In any case in which a fluid other than alcohol has been used for hardening, the reagent must be entirely removed by immersion in spirit. The length of time required for staining can only be learnt by experience, but over-staining need not be feared. When the paraffin or celloidin methods are used, the best way is to immerse the slide, to which the section is stuck on in a wide-mouthed vessel filled with stain. Both stains give excellent results in photomicrography by lamplight, owing to the sharp nuclear definition and slight staining of the other tissue elements.

Preparing Picrocarmine.*—The following, according to the 'Magazine of Pharmacy,' is an improved method of preparing picrocarmine for microscopical purposes:—

About half a gramme of carmine is dissolved in 100 ccm. of water containing 5 ccm. of a 1 per cent. solution of soda. The liquid is then boiled, filtered, and made up again to 100 ccm. by addition of distilled water. In order to neutralize the solution, it is mixed with an equal volume of water, and a 1 per cent. solution of picric acid is then added. This at first causes a turbidity to appear, but it subsequently disappears. If not, it indicates that the point of neutralization has been overstepped.

Staining with Rosanilin Nitrate in watery Glycerin Solution.†—Dr. W. Flemming states that Böttcher has for a long time stained preparations previously treated with Müller's fluid and alcohol with rosanilin nitrate in a watery glycerin solution; then passed through alcohol, cleared up in creosote, and mounted in dammar or balsam.

New Injecting Mass.‡—Dr. M. N. Miller has devised the following injecting mass:—

First procure some thin, clear, colourless French gelatin in sheets about 3 in. by 8 in., with crossed markings. To 1 oz. of gelatin add 10 oz. of water. Allow the gelatin to swell for one hour, and then place the vessel containing the whole in a kettle of boiling water, and allow it to remain until the gelatin melts thoroughly. Strain through previously moistened flannel into, preferably, a flask. While yet warm and fluid, pour about half of the gelatin into another glass vessel. Dissolve in the one half two grains of dry common salt, and in the other half ten grains of nitrate of silver. Should the gelatin become stiffened by cooling, it must be warmed and so kept fluid. When all is dissolved, mix the two gelatin solutions and shake briskly for from three to five minutes. Add 10 grains of citric acid and keep the gelatin warm until the former dissolves. This is the injecting mass, and is ready for use. If filtered first through paper the solution will be clearer, but this is not absolutely essential.

The colour of the injection mass in the mounted section is a beautiful purple, and perfectly translucent. The differentiation between arterioles, venules, and capillaries is perfect, and the larger the vessel, the darker the colour of the mass. The citric acid must be put in last, and metal vessels must not be used, as the silver salt would act upon them. The mass is not spoilt if partly darkened before use.

* Scientif. News, i. (1888) p. 319.
† Arch. f. Mikr. Anat., xxx. (1887).
‡ Amer. Mon. Micr. Journ., ix. (1888) pp. 50–1.

FREEBORN, G. C.—**Notices of New Methods. II.**
[Celloidin-paraffin imbedding and carmine staining (Kultschizky). New staining medium (Plattner.)]
Amer. Mon. Micr. Journ., IX. (1888) pp. 52–3.

HVASS, T.—**Om nyare färgningsmethoder vid histologiska studier af nervväfnad.** (On new staining methods in the histological study of nerve-tissue.)
Hygeia, XLIX. (1887) p. 50.

LENNOX.—**Beobachtungen über die Histologie der Netzhaut mittels der Weigert-schen Färbungsmethode.** (Observations on the histology of the retina by means of the Weigert staining method.) *Graefe's Arch. f. Ophthalm.*, XXXII. (1887).

LINDNER, P.—**Gefärbte Hefenpräparate.** (Stained yeast preparations.)
Wochenschr. f. Brauerei, 1887, p. 773.

SOUZA, A. DE.—**De la pyridine en histologie.** (On pyridine in histology.)
C.R. Soc. Biol., IV. (1887) No. 35.

(5) Mounting, including Slides, Preservative Fluids, &c.

Medium of High Refractive Index.—Mr. Arthur E. Meates, who has been for more than two years past experimenting upon Prof. Hamilton L. Smith's,* and other media of high refractive indices, considers the following to be his most successful result:—

Put into a 4-in. test-tube 71½ grains of bromine, add 28¾ grains of sulphur, and warm gently until combined; then add 67 grains of *freshly sublimed* arsenic by very small portions at a time, otherwise the violent action which takes place between the bromine and arsenic will cause the mixture to boil over. After about 20 grains have been added this violent action ceases, and then the rest of the arsenic can be put in at once. When the whole of the arsenic is added, boil gently until it is completely dissolved, which will take about fifteen or twenty minutes. While boiling care must be taken that the vapours of bromide of arsenic (which can be seen mounting up the tube) do not escape. If properly made, thin films of the medium, when cold, will be of a pale-yellow colour. Its refractive index is high, considerably above that of phosphorus. It melts at about 200° Fahr.

For mounting, the medium should be warmed till it is quite liquid, a small portion taken out on a glass dipping-rod, dropped on a warm slide, and, while soft, the cover with the diatoms pressed upon it. When cold, the superfluous medium may be scraped away and the mount ringed with copal or any other varnish that does not contain alcohol. Hitherto, it has shown no signs of deliquescence or crystallization, although put to most severe tests.

The medium is practically *orpiment* dissolved in bromide of arsenic; but this solution cannot be effected satisfactorily, except by combining the substances while in a nascent condition. It can, however, also be made by dissolving the proper proportions of sulphur and arsenic in a certain amount of bromide of arsenic. It differs from Prof. Smith's medium, which is stated to be "realgar, the transparent sulphide of arsenic, dissolved in bromide of arsenic by aid of heat";* realgar being As_2S_2, and orpiment As_2S_3.

Wax Cells.†—Dr. Taylor in describing his method of making wax cells, says that much complaint has been made about these cells on account of their becoming "foggy." This may occur if cells are

* See this Journal, 1885, p. 1099.

† Report of Proceedings at Washington Microscopical Society. Cf. Engl. Mech., xlvii. (1888) p. 29.

made from sheet wax, as in its preparation it is passed between rollers which are continually wet, and much moisture is absorbed. The best way of making wax cells is to melt common beeswax over a spirit-lamp; add to it 5 per cent. of resin; after the whole is melted, slightly lower the temperature, but not so much as to solidify the mass in any degree. Slides can then be placed on the turntable and cells ringed in a moment. A cell can be made and varnished in ten minutes. The wax rings may be covered with a mixture of glycerin and solution of gum-arabic, and the cover-glass then be put on and pressed down. The solution becomes hard very soon, and the cover-glass is firmly cemented.

Shellac Cement.*—Mr. W. N. Seaman gives the following directions for making a strong and lasting cement for attaching metal to glass.

Take 50 grm. of *unbleached* shellac, add to it 50 ccm. of commercial alcohol, and then cover the mixture with an equal quantity of kerosene oil, shake the mixture frequently for the first two or three days, and then set it away for a month, or until it separates into four layers as follows beginning at the top:—(1) Kerosene. (2) A layer of woolly-looking stuff. (3) Clear shellac. (4) Sediment. By means of a pipette or any other convenient way, draw off the shellac, and to each 50 parts of it add one part of boiled linseed oil.

WARD, R. H.—**Instantaneous Mounting in Farrants' Gum and Glycerin Medium.**
[Useful directions for mounting in this medium, which is too much neglected now-a-days. As the author says, "too much can scarcely be said in its favour for facility of use."]
13*th Ann. Rep. Amer. Post. Micr. Club*, 1888, pp. 13–14.

(6) Miscellaneous.

James's Teasing-Needle.†—Fig. 95 shows the form of a teasing needle which Dr. F. L. James has used for some time past in lieu of the old straight and curved needles, over which it possesses (it is claimed) many and manifest advantages. It may be held in the hand exactly as a pen-holder, and when two are used the curved portion may be laid flat on the material, thus holding it in place while it is teased out by the aid of the other. The points may be made of heavy straight needles, the temper of which is drawn by holding for a moment in the lamp. A better material, however, is old umbrella wires drawn and filed down. The fig. gives about the proper curvature.

FIG. 95.

Medico-legal Identification of Blood-stains.‡—M. Ferry describes a method for the identification of blood-stains. While differing in an important particular from that of Ranvier, the method is not entirely new. It is as follows:—

If the stain be upon woven fabric the fibres are to be teased out and put into a test-tube and covered with a solution of sodium chloride 1:1000. After standing a while the fluid will become a brownish red. Examined by the spectroscope, if the stains were made by blood the hæmoglobin lines will appear. The examination for blood-corpuscles may now proceed. For this purpose, to each ccm. of the saline solution add one minim of a saturated solution of chloral hydrate, and if blood

* Amer. Mon. Micr. Journ., ix. (1888) pp. 53–4.
† St. Louis Med. and Surg. Journ., liv. (1888) pp. 167–8 (1 fig.).
‡ Ibid., pp. 165–6.

be present a rose-red precipitate will be formed. Allow it to settle, and remove with a pipette a drop of the precipitate, and place on a cover-glass. Hold this for a moment over the flame of a spirit-lamp, and with a bit of absorbent paper take up the clear liquid which forms. A drop of fuchsin or magenta is now added and allowed to remain a few minutes, or long enough to stain the pellicle on the cover-glass. Wash in water and clear with acetic acid. If blood-corpuscles be present they will appear stained a bright red.

Dr. F. L. James makes some suggestions as to carrying out the process. It very frequently happens that the authorities (or sometimes the attorneys for the defendant) will not allow a fabric to be cut or mutilated, for reasons which are obvious. In two such cases in which he carried out the examination, he proceeded as follows:—The saline solution (1:1000) was placed in a small glass saucer or watch-glass, and the cloth (a handkerchief in one instance, a linen cuff in the other) was folded across one of the spots. The surface was rubbed together some moments, and then carefully turned over so that the abraded surfaces rested face downward in the saucer, touching the fluid. Holding it firmly on the edges of the little vessel, a paper-knife was rubbed several times over the spot from the back. The brownish-red or iron-rust colour rapidly imparted itself to the fluid, and after letting the glass stand for a few hours a drop removed from the bottom disclosed the blood-corpuscles under the Microscope. In cases where a very small piece of the stained material may be removed, the picking to pieces should be done in a watch-glass, and the saline solution poured over it.

Microscopical Examination of Paper.*—Herr J. Wiesner publishes the results of a microscopical examination of the paper in the El-Faijûm collection, made by the Arabs in the eighth and ninth centuries. He finds that it was not made, as has been usually supposed, from "raw" or unmanufactured cotton, but from linen rags, an invention which has usually been ascribed to the fourteenth century. The chief constituent of the paper is linen, among which are traces of cotton, hemp, and of several animal fibres. Well-preserved yarn-threads are of frequent occurrence. The invention of linen-paper is, therefore, neither Italian nor German, but Eastern. The paper was invariably "clayed," the substance used being always starch-paste, and not in the rough state, but prepared starch, apparently from wheat. In the tenth and eleventh centuries buckwheat-starch was employed. The materials used for writing were apparently iron tannate, Indian ink, and carbon.

The author further examined more than 500 Eastern and European papers, ranging from the ninth to the fifteenth century, not one of which was made from "raw" cotton; the greater number were made of linen, and "clayed" with starch-paste; the use of glue or resin for this purpose begins with the fourteenth century.

Illustrations to Microscopical Publications.†—The editors of 'The Microscope' write on this subject as follows:—

"In looking over the various text-books and other publications dealing with microscopical subjects, one cannot fail to be impressed with the clear fine-cut appearance of the usual illustrations. To one not familiar with the subject, a study of many of these illustrations should lead him to the conclusion that microscopy, so far as observation goes,

* Wiesner, J., 'Die Mikroskopische Unters. d. Papieres, 1887, 82 pp., and 15 figs. See Bot. Centralbl., xxxiii. (1888) p. 340.

† The Microscope, viii. (1888) p. 60-1.

is not a difficult thing to master. And this, indeed, has been the case in our experience with students who have come to us for instruction in histology. The first rude awakening often comes to the beginner when he takes his text-book cut as a guide to lead him through the intricacy of his first mount. Everything looks so differently from what he expected, and even the instructor, in attempting to point out the features so clearly displayed in the cut, will for some time meet with but feeble success. It may be urged that the difficulty is that the eye requires a special training to enable it to convey a correct impression under conditions to which it is not at all accustomed. This is very true; but is it the only reason for such complete (and not uncommon) failures to see anything at all? It seems to us that one cause of failure is to be looked for in the illustrations, and the reason is, generally, that they are too diagrammatic. We think that the better class of illustrations in question are very helpful to the advanced worker, not because they are true pictures—for they are not—but that he has learned to take something for granted, and to make just the proper allowances to enable him oftentimes to know exactly what the artist intended. No specimen, however well prepared, can show such clear differentiation of its component parts as the illustration which represents it. The latter has caught the general features, exaggerated them, and bothered not at all with the spirit of its subject. The aim, moreover, has been apparently to picture the specimen not as it looks, but as it is. For the benefit of the beginner this should be reversed; he must first learn to see the specimen as it looks, and then be taught to know it as it is.

The difficulties at the root of the matter seem to be (1) the fact that the delineations are not confined to that which is seen at a single focus, but are deduced from a knowledge gained by a study of several focuses, and (2) the process employed.

(1) It is this which makes complete tubules in a section where there are few, if any, and which fills up the indistinct spaces with ideal representations of that which, though not seen, is known to be there.

(2) The process usually employed makes use of distinct lines, something seldom seen in a specimen. A skilful artist could probably etch a tolerably correct picture, and he would do so by carefully toning down his lines to the proper degree.

Photography and many new processes are coming into use, some of which, it is hoped, will prove more satisfactory. And yet we think that much better work could be done with the method now in vogue (drawing with the use of a camera lucida and photo-engraving the result) if the artist confined himself to drawing that only which he sees at one focus, and conserving that blending of parts which, though sometimes amounting to indistinctness, has at least the merit of being natural."

Leeuwenhoek's Discovery of Micro-organisms.*—Herr J. F. Schill points out that 1674 and not 1675 should be taken as the date of Leeuwenhoek's discovery of organisms. Attention is directed to a letter dated Sept. 7th, 1674, which appears in the 'Philosophical Transactions' of Nov. 23rd, 1674, and which seems to confirm his contention.

Collected Papers of T. R. Lewis.†—The 'In Memoriam' volume which contains the collected papers of the late Dr. T. R. Lewis should be

* Zool. Anzeig., x. (1887) pp. 685-6.

† Published by the Lewis Memorial Committee. 4to, London, 1888, 732 pp., 43 pls., and numerous woodcuts.

brought to the notice of microscopists, for it contains a number of valuable papers which have hitherto been very difficult of access, owing to their having been published in official Indian reports, or in Indian medical journals; we may cite the 'Report on Bladder-worms,' 'The Microscopic Organisms found in the blood of Man and Animals, and their relation to disease,' the memorandum on the Comma-bacillus, and other reports on the agent or agents which produce cholera.

Cole's Microscopical Preparations.—We are naturally opposed in principle to *free* advertisements, but Mr. A. C. Cole has done such a large amount of valuable work in the extensive series of microscopical preparations that he has from time to time placed at the disposal of microscopists, that we cannot but call attention to the fact that though he has been obliged to discontinue the publication of his descriptions of preparations he still continues to issue the preparations themselves in the same condition of excellence as before. Any support given to Mr. Cole will be well directed in the interest of microscopy.

Enock's Insect Slides.—While Mr. F. Enock works in a more limited sphere than Mr. Cole his slides are, as is well known, quite unique of their kind as models of mounting, and Mr. Enock deserves a large measure of appreciation at the hands of microscopists. Mr. Enock supplies with his slides a description with figures illustrating the chief points, which, as we have before noticed in these pages, largely increases their value.

ADAN, H. P.—**Le Monde Invisible dévoilé. Révelations du Microscope.** (The Invisible World revealed. Revelations of the Microscope.)
New ed., 506 pp. and 24 pls., 8vo, Bruxelles, 1888.

BRIGGS, D. H.—**Beautiful Micro-polariscope Objects.**
[Salicin and hippuric acid.] *Journ. N. York Micr. Soc.*, IV. (1888) pp. 115–7.

BROWN, F. W.—**A Course in Animal Histology. I.** (*concld.*). **Instruments and Reagents. II. Cells and Intercellular Substances.**
The Microscope, VIII. (1888) pp. 57–8, 113–6 (4 figs.).

HOBBS, W. H.—**On the use of the Microscope in Petrography.**
Amer. Mon. Micr. Journ., IX. (1888) pp. 70–4.

JAMES, F. L.—**[Physicians and the Microscope.]**
["If physicians would only try the experiment for a few times of consulting the Microscope in their doubtful cases of urinary disorders, we feel assured that they would never again attempt to treat these disorders without a competent microscopical examination. We feel further assured that when one becomes acquainted with the value of the Microscope in this particular direction, he would be impelled to apply the same instrument and methods to the diagnosis of other troubles. He who fails to do so deliberately throws away the most powerful aid to diagnosis yet discovered."]
St. Louis Med. and Surg. Journ., LIV. (1888) p. 96.

LATHAM, V. A.—**The Microscope and how to use it. XIV.**
[Practical Notes on Histology. Special Methods for examination of the Spinal Cord, Brain, &c.]
Journ. of Micr., I. (1888) pp. 102–6.

,, ,, **A few good Objects for the Microscope.**
[Sections of laburnum wood, deal, and rhubarb; scales of the sulphur and cabbage butterflies; goldfinch's and lark's feathers; elder pith; and palates of molluscs.]
Scientif. Enquirer, III. (1888) p. 7.

MANTON, W. P.—**Rudiments of Practical Embryology. II. Material.**
The Microscope, VIII. (1888) pp. 58–60 (1 fig.), 110–3 (2 figs.).

MILLER, M. N.—**Practical Microscopy: A Course of Normal Histology for Students and Practitioners of Medicine.** xv. and 217 pp., 8vo, New York, 1887.

PROCEEDINGS OF THE SOCIETY.

Meeting of 11th April, 1888, at King's College, Strand, W.C., Prof. C. Stewart, Vice-President, in the Chair.

The Minutes of the meeting of 14th March last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Baker, H., Essai sur l'Histoire Naturelle du Polype; traduit par M. P. Demours. viii. and 359 pp. and 22 pls. (8vo, Paris, 1744)	*Mr. Crisp.*
Brown, R., Brief Account of Microscopical Observations on the Particles contained in the Pollen of Plants. 16 pp. (8vo, London, 1828)	„
Bruguière, J. G., L'Helminthologie, ou les Vers Infusoires, &c. viii. and 83 pp. and 95 pls. (4to, Paris, 1791)	„
Bütschli, O., Studien über die ersten Entwicklungsvorgänge der Eizelle, die Zelltheilung und die Conjugation der Infusorien. 250 pp. and 15 pls. (4to, Frankfurt a. M., 1876)	„
Ehrenberg, C. G., Mikrogeologische Studien über das kleinste Leben der Meeres-Tiefgründe aller Zonen und dessen geologischen Einfluss. 266 pp. and 12 pls. (4to, Berlin, 1873)..	„
Gluge, G., Pathologische Histologie. 77 pp. and 11 pls. (4to, Jena, 1850)	„
Haeckel, E., Das System der Medusen. Erster Theil. x. and 360 pp. and 40 pls. (4to, Jena, 1879)	„
Hertwig, R., Zur Histologie der Radiolarien. Untersuchung über den Bau und die Entwicklung der Sphaerozoiden und Thalassicolliden. 91 pp. and 5 pls. (4to, Leipzig, 1876) ..	„
Jurine, L., Histoire des Monocles, qui se trouvent aux environs de Genève. xvi. and 258 pp. and 22 pls. (4to, Genève, 1820)	„
Lardner, D., Optics. Handbook of Natural Philosophy. xvi. and 432 pp. and 289 figs. (8vo, London, 1856)	„
Laurent, P., Études Physiologiques sur les Animalcules des Infusions Végétales, comparés aux organes élémentaires des Végétaux. 2 vols. (4to, Nancy, 1854–58)	„
Leydig, F., Naturgeschichte der Daphniden (Crustacea Cladocera). 252 pp. and 10 pls. (4to, Tübingen, 1860)	„
Liljeborg, W., De Crustaceis ex Ordinibus Tribus: Cladocera, Ostracoda et Copepoda, in Scania occurrentibus. xv. and 222 pp. and 26 pls. (8vo, Lund, 1853)	„
Pallas, P. S., Elenchus Zoophytorum. 451 pp. (8vo, Hagæ Comitum, 1766)	„
Roumeguère, C., Cryptogamie Illustrée, ou Histoire des Familles Naturelles des Plantes Acotylédones d'Europe. Famille des Lichens. 73 pp. and 187 figs. (4to, Paris, 1868)	„
„ „ Famille des Champignons. 164 pp. and 567 figs. (4to, Paris, 1870)	„
Slides of *Aulacodiscus orientalis* and *Biddulphia echinata* n. sp. ..	*Mr. Kitton.*
Photomicrographs (12)	*Mr. J. B. Shearer.*

Mr. Crisp said that he had received a letter from the President, in which he expressed the great regret which he felt at being still obliged to remain at home, the accident to his knee necessitating his confinement to one floor of his house.

Mr. J. Mayall, jun., described a somewhat remarkable instrument from Mr. Crisp's collection, which he thought most persons would at first sight be inclined to mistake for one of the old forms of reflecting telescope, but which was really a Microscope, dating probably from the commencement of the present century. It bore the name of Adams as the inventor, and seemed to be a combination of an ordinary compound Microscope and a projection Microscope, to be illuminated by a lamp, or possibly by sunlight, though he scarcely inclined to the idea that this was intended because the body had no movement in azimuth, but only in altitude. The apparatus belonging to it was of an elaborate kind, comprising various arrangements for carrying objectives of different foci, also a spring stage and a very complicated stage on which opaque objects could be viewed. There was a circular ground-glass screen for receiving projection images, which fitted in a slot in the body-tube. The instrument was evidently intended as a type of a first-class Microscope of its day, both from the complexity of the design, and from the care and finish bestowed on the workmanship. He had not yet been able to meet with any description or figure of it.

Mr. C. Curties exhibited two photomicrographs by Dr. Roderick Zeiss, of Jena, viz.:—

Amphipleura pellucida × 2000 partly resolved into beads, taken with an apochromatic 3·0 mm. N.A. 1·40 oil-immersion objective.

Pleurosigma angulatum × 4900 taken with an apochromatic 2·0 mm. N.A. 1·30 oil-immersion objective.

Mr. J. Mayall, jun., considered these photomicrographs would bear comparison with any they had yet seen. It would be remembered that about a year ago they received some from Dr. Van Heurck, of Antwerp, and Dr. Millar at the time called attention to the one of *P. angulatum* in comparison with a transparent photograph by Nachet, of Paris, which had been in the possession of the Society since 1867. In the case of these now exhibited there was distinct progress shown; in that of *Pleurosigma angulatum* the features were beautifully defined and the curious diffraction effects were well shown. The object itself was not a difficult thing to photograph, but, with a power as high as that used (× 4900), to make a good picture was not an easy matter. The photograph of *Amphipleura pellucida* showed the striations partly resolved into beads, but in this case the resolution did not come out so clearly as in the photograph by Dr. Van Heurck; whether this beaded appearance was real or whether it was the effect of improper illumination, as Mr. Nelson alleged it to be, was a question which he must leave to others to decide. During a visit to Antwerp, Dr. Van Heurck showed it to him by means of the electric light; therefore he had no doubt as to its being seen. But it was worth mentioning that Dr. Zeiss used an electric arc lamp in his experiments, and this method of illumination was so unsteady—never two moments alike—and it altered the image so frequently, that he doubted very much the possibility of getting the finest effects by means of it. On the other hand, Dr. Zeiss had every possible appliance at his command which could contribute to success. He had concrete floors in his atelier, so as to ensure freedom from vibration; and he had also the pick of the fine lenses produced at his works, so that if he could not produce good photographs, it was difficult to say who could.

Mr. Ingpen asked if Mr. Mayall considered that the appearance of beading was due simply to the intermittence of the arc light and nothing else?

Mr. Mayall could not say exactly to what it was due, but he thought unsteadiness in the light was not the sole cause, because he had seen it with the incandescent electric lamp—which was what Dr. Van Heurck used—and this was one of the steadiest lights known. He had also seen it with the oxyhydrogen light, and with sunlight he had seen it very well indeed. Whether it was a false impression or not was another matter.

Mr. Crisp said that at the last meeting Prof. Stewart referred to some slides said to be mounted in "Suffolk," and that Mr. Suffolk, who was present, whilst disclaiming all knowledge of the matter, thought it might possibly be something which he had at some time or other recommended. Since then they had received a letter from Mr. J. W. Gooch, giving the explanation that an old friend of his who lived in the county of Suffolk invented this medium, but would never divulge the secret of its composition, and when any one pressed him as to what the slides were mounted in, he used to reply that "they were mounted in Suffolk." Hence the term came to be applied as if it was the name of the medium.

Mr. Crisp referred to Prof. Rücker's suggestions in 'Nature,' with reference to the use of the term "micromillimetre," and reported that the Council, after some consideration of the subject, had ultimately determined to recommend the abandonment of "micromillimetre," and the use of the term "micron" to indicate the 1/1000th part of a millimetre (*supra*, p. 502).

Mr. A. Meates's paper "On a new Mounting Medium of High Refractive Index" was read by Mr. Ingpen, who said that Mr. Meates would be pleased to correspond with any Fellow who might be interested in the subject, or he would be glad to assist them in mounting any difficult diatoms in this medium (*supra*, p. 519).

Mr. Crisp read a letter from Mr. Julien Deby, explaining the process of obtaining photomicrographs employed by Messrs. Truan y Luard and O. Witt, who stated that when an amplification of 500 diameters was required, the best results were obtained by making a negative of 100 diameters with a low power, which could then be enlarged to 500 diameters by an ordinary photographic copying process. (*Ante*, p. 295.)

Mr. T. C. White said he had already tried that plan, but it required the original photograph to be so remarkably sharp that very few persons were likely to succeed in doing it to their satisfaction.

Mr. Crisp inquired whether any one present had any experience of the advantage to be obtained by photographing an object × 100 and then enlarging it × 5?

Mr. T. C. White said he would himself much rather take it with the higher magnification at once.

The Chairman asked if taking it upon the larger scale would not involve an inconvenient loss of light.

Mr. T. C. White said they certainly would lose light, but that only

meant that a longer exposure would be required to get the same effect. He had not done anything himself with a greater amplification than × 200, but up to that magnification he had not found a want of light to present any difficulty, in fact, he thought the mistake most often made was that of having too much light thrown into the objective. In practice he found it frequently necessary to cut off some of the light in order to prevent the details of the picture from being blurred by too much glare.

Mr. J. Mayall, jun., said he had made a great many experiments in this direction with high powers from × 200 up to × 1000 or more, and he might say that his experience went to show that the difficulty of getting good results with high magnifications direct from the object was considerable, especially where a long exposure was required. In such cases the risk of vibration was so great that very few photographs taken in that way were successful. Even Dr. Woodward, who had such precautions taken as concrete floors to his workroom, frequently experienced the difficulty arising from this cause. Mr. Mayall also referred to instances of the improper use of the condenser, which was either not placed correctly, or not centered, or the light was not properly focused; whereas to produce good results the object must be evenly illuminated.

The Chairman said that few persons were so well able to give an authoritative opinion on this subject as Mr. Mayall, so that they were much interested to hear the remarks which had fallen from him. As regarded high-power work, there could be no doubt that the centering of the condenser was a very important consideration, but he thought it was possible that where an object was photographed under a low power there might be some advantage indirectly gained by an unequal illumination, and that appearances would result which might help them in some way to form an estimate of the real form. It might in reality be an imperfection, but it might, notwithstanding, have some practical utility.

Mr. Mayall said doubtless every kind of illumination might be said to contribute more or less to the accurate interpretation of images seen in the Microscope. In cases, however, where an unequal illumination was thought desirable, there were recognized methods of obtaining such illumination. There were central stops, and a great variety of movable stops, that could be used at pleasure either alone or in combination with diaphragms of different sizes; the employment of such means was most important to enable the observer to interpret structure, especially, too, as he could record exactly the method employed, so that his results could be repeated by himself or others. But the unequal illumination which he observed in a great many photomicrographs submitted to the Society was due to imperfect adjustment of the condenser, imperfect adjustment due in most cases to want of training in the skilful employment of the Microscope and accessory apparatus. Such unequal illumination of the field of the Microscope was, for the most part, not an effect deliberately sought for by the microscopist, but was obtained hap-hazard, without any systematic manipulation capable of being recorded and repeated. It was this unskilful microscopy which he hoped to see remedied; for when it came to be combined with inferior technical photography, which he regretted to say was far too often the case, then the results were by no means admirable. It should surely be an essential part of the training of a microscopist to be able to centre and otherwise adjust his condenser and regulate the illumination; such matters were the A B C of

microscopy. If, further, it were desired to apply photography to the Microscope, the microscopist should either master the technicalities of photography, or call in trained assistance in that department. He thought it was hardly treating the Society fairly to submit to their notice photomicrographs which showed neither skilful manipulation with the Microscope nor passably good photography. Several of the photomicrographs recently received from America seemed to him extremely defective; they evidenced utter want of training in the management of the Microscope, selection of the object, &c., while as to the photography, it was simply beneath criticism; the negatives were all over-exposed or under-exposed, over-developed or under-developed. He must, however, admit that the prints were well burnished; that was their one redeeming point.

Mr. T. C. White said he could quite endorse Mr. Mayall's opinion as to the necessity for strictly centering the condenser; if this was not done, they would get half the field in shade and the other half in light. It must be properly centered and then moved back until they got an equal illumination all over, and this was equally necessary, whether they worked with high powers or low. It was also quite a matter of common experience that most of the photographs they saw were like those which had been handed round, some being very much under-exposed, and some over-exposed.

Mr. J. D. Hardy said there were two considerations of importance in the suggestions made for improving a photograph by taking it first with a low power and afterwards enlarging it. In photographing a Floscule under a high power he should want more time and more light, but by using a low power first he took much less time over the process, and thus got a perfect image; whereas if a longer time had been required, the Floscule might have moved meanwhile, and so spoilt the result. Also the effects of vibration in taking a large image would be reduced so much by taking a low-power image first, that he thought a great advantage would be gained on that account.

Mr. J. Mayall, jun., said that, as regarded the subject of the original communication, he thought there was both truth and untruth in the recommendation. Where a power of × 100 was enough to show the structure of the object, then he would say do as the authors recommended; but if it needed a power of × 500 to reveal the structure, then it was of no use whatever to photograph with × 100 and afterwards enlarge to × 500.

Mr. Crisp called attention to Galland-Mason's "Microphotoscope," and read extracts from the inventor's patent specification. (*Ante*, p. 281.)

Mr. Kitton's communication was read describing a new species of *Biddulphia* (*B. echinata*) from Fiji, specimens of which were shown under Microscopes in the room. (*Supra*, p. 466.)

Dr. R. H. Ward's report on his examination of Fasoldt's plates of ruled lines was read, in which he showed that the maker himself was in reality unable to see more lines to the inch than the Abbe theory allowed should be visible. (*Ante*, p. 298.)

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—*Dendrosoma radians.*

Mr. Crisp:—Adams's large Microscope.

Mr. Kitton:—*Biddulphia echinata* n. sp.

Mr. A. Meates:—*Navicula rhomboides* mounted in new medium.

Mr. J. B. Shearer:—Photomicrographs of various microscopic objects.

Dr. R. Zeiss:—Photomicrographs of *Amphipleura pellucida* and *Pleurosigma angulatum.*

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. Thomas W. Cave, M.R.C.V.S., John Dimsdale, John H. Mummery, M.R.C.S., George Pearce, William H. Pratt, Adolf Schulze, A. Norman Tate, F.I.C., F.C.S., Frederick W. Thompson, and Rev. H. Armstrong Hall. Prof. G. Govi, Prof. Sven Lovén, and Prof. R. Virchow were elected *Honorary* Fellows.

Meeting of 9th May, 1888, at King's College, Strand, W.C., The President (Dr. C. T. Hudson) in the Chair.

The Minutes of the meeting of 11th April last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

Cross, C. F., E. J. Bevan, & C. M. King, Report on Indian Fibres and Fibrous Substances. vi. and 71 pp. and 5 pls. (8vo, London, 1887)	From *The Authors.*

The President said that on the occasion of his taking the chair for the first time, he desired, before beginning the business of the evening, to thank the Fellows very heartily for the honour which they had done him in electing him their President. He confessed that when he heard the news it filled him with a kind of fearful joy, because Dr. Dallinger's great services during the four years he had held the office had been so conspicuous as to add a distinction to the position which made it difficult to approach, much less to emulate. But whatever, under the circumstances, his own failings and shortcomings might prove to be, he could assure them that he should not fail in trying to do his best.

Mr. Crisp exhibited a form of camera lucida by M. Dumaige, of Paris, fitted in a box with a cover, which, when closed, kept the prism and mirror free from dust. Also, by the same maker, an adapter with spiral springs for rapidly changing objectives, and a portable Microscope in which the foot and stage were in one piece (*supra*, pp. 476, 487, and 488).

Dr. Kibbler exhibited and described a new stand and camera, which, he believed, would be found very useful for photomicrography. It had been made to his design by Mr. Bailey, his idea being that it was best

not to take negatives upon a large plate, but on a quarter-plate first and afterwards to enlarge the pictures from the original negatives. Specimens of such enlargements were also exhibited enlarged about nine times from the originals. The great advantage of this method was in the amount of light gained for the purpose of focusing. If a good sharp picture was produced, the gelatin plate would admit of considerable enlargement up to the point where the grain began to show. This quarter-plate size was also the proper one for lantern slides, which were so much in request at the present time for purposes of demonstration. In the ordinary forms of stand the diaphragm plate is placed immediately below the stage; but, for photographic purposes, this was, in his experience, entirely useless, because it only cut off the edge of the field without either improving definition or correcting spherical aberration. In practice, he had found that by removing the diaphragm plate a certain distance from the object it then ceased to cut off the field and began to reduce the light and to improve the penetration and definition. Opticians, he knew, were inclined to doubt whether this arrangement would do what he claimed for it; but he could only say that, with a good light he could easily show that such was the fact. In cases where high powers were used this answered very well; but it would not work, however, with low powers unless the diaphragm plate was removed to a distance too great to be convenient in practice. He had now, therefore, devised the plan of introducing a short $1\frac{1}{2}$ in. condenser behind the stage, and about 3 in. in front of the diaphragm plate, in this way throwing it out of focus. The effect of this was that the same improvement in penetration and definition was obtained, but on a much shorter distance. The use of the diaphragm was of the utmost importance in photography where the most perfect focusing and definition were required. Attention was also called to a method of clamping the object in position when the focus had been obtained; also to a plan for obtaining a fine-adjustment by means of a tangent screw.

Mr. Beck said he did not usually like criticizing matters of that sort, because he was one of those who had great doubts as to the value of photographic images produced by the Microscope. Photography might produce what was seen by the eye; but in many cases they were frightful distortions. If they looked at the photograph shown of the proboscis of the blow-fly, they would see that it showed every hair as being double, an effect which he considered was due to the removal of the diaphragm having caused distortion by diffraction. If a diaphragm was of any use at all it was to cut off certain rays which caused indistinctness of focus, or to cut off the central rays, so that the circumferential rays could be used alone, and the object in photography should be to get rid of all those inaccuracies which a diaphragm, when it was properly used, would get rid of. He did not wish to criticize the apparatus before them, which seemed to be beautifully made, except that he thought there was rather an inconvenient distance to stretch out in order to reach the focusing screw.

Mr. Teasdale said he had practised photography more or less for the last thirty years, and had never found it necessary to pay the slightest regard to the diaphragm, although he might have occasionally used a temporary one. In the case of photomicrography, the place for it was certainly behind the lens. The chief difficulty in focusing was due to want of light. Focusing should always be done with as much light as

possible, and then having used the whole aperture, the light should afterwards be reduced to sharpen the object. To insure success, extremely accurate focusing was necessary, and to obtain this it was well to put a plate on with some object mounted upon it—say, some diatoms. This was easily obtained by pouring a little water containing diatoms upon the glass and letting it evaporate, when the diatoms would be left adhering to the glass; then focus and get an aërial image. He quite agreed as to the value of the quarter-plate size. It was undoubtedly the most useful for lantern plates and for enlargements, and he entirely concurred as to the benefit to be obtained from taking negatives first on a smaller scale and enlarging afterwards; but he had very decided opinions as to the uselessness of diaphragms behind the object.

Dr. Kibbler said as regarded the hairs he could only say that the image of the object when seen on the ground glass appeared very much worse than in the photograph, each hair showing as if composed of three or four. The photograph was not taken with a small diaphragm. It had an exposure of ten minutes with an ordinary paraffin lamp. If he had a good light he could demonstrate to any one in the room the use of the diaphragm plate in improving the image when used in the way he had described. With small objects like blood-discs diffraction images appeared.

Mr. Crisp said that since their last meeting various London and provincial papers had published a most astounding piece of rubbish in reference to an alleged "new glass just made in Sweden." Many of the Fellows and others had forwarded cuttings to the Society (*supra*, p. 499).

Mr. Crisp also called attention to the fact that the 14th (1888) edition of Heather's 'Mathematical Instruments' had been issued, with the description of the Microscope which was given in the first edition unaltered and uncorrected. In particular, it is made to appear that the "amplifying lens" of bygone days is, with the eye-lens, field-lens, and objective, an essential part of a compound Microscope, while a whole page is devoted to the reflecting Microscope, none of which have been made since 1840 (*supra*, p. 501).

Mr. Mills's note on "A Sponge with Stelliform Spicules" was read by Prof. Bell.

Mr. Crisp referred to some comments which had recently been made in America upon the advantages of the method of tilting the stage of the Microscope as a means of obtaining a very economical and simple fine-adjustment. This idea was not by any means new, as might be seen by an examination of the various Microscopes upon the table, in each of which it had been carried out in a different way (*supra*, p. 478).

Mr. J. Mayall, jun., said his main objection to this form of fine-adjustment was that for high powers it was not possible to properly use a condenser. Focusing by tilting the stage not only involved the movement of the object in relation to the objective, but also in relation to the substage condenser. Under such circumstances he thought it was hardly possible to carry on a delicate microscopical investigation satisfactorily.

Mr. Beck said that to allow the stage to move in any direction except parallel to its plane, at once destroyed all delicate effects. Let them take such an object as a *Podura* scale, and they would find that if they

moved the stage in any degree, however slightly, which was not parallel, the appearance of it would be materially altered. Anything which interfered with the parallel position of the stage must be destructive of true definition.

Mr. J. Mayall, jun., said he agreed very much with Mr. Beck in the remarks which he had made; but he thought if they took objection to the movement upon the ground stated, they must take objection also to the "Bausch and Lomb" fine-adjustment, where the body-tube was hung on two parallel pieces of clock-spring, and which he assumed was a movement in arc, although it did not alter the relation of the object to the condenser.

Mr. Beck said that the movement was a parallel movement and not a tilting movement. The Bausch and Lomb arrangement was not the same thing at all as the other, because the same parallelism was maintained, whereas in the tilting pattern they had the optical axis thrown out of line perpendicular to the object.

Mr. J. Mayall, jun., said that as he understood it, the Bausch and Lomb movement compelled them to see a different portion of the surface of the object with every change of the focal adjustment.

Mr. Beck repeated that although this was so, parallelism was maintained. Some discussion took place as to whether the movement of the tube was not in reality in arc; but it was ultimately conceded that Mr. Beck's view was correct.

Dr. A. C. Stokes's paper on "New Infusoria Flagellata from American Fresh Waters," containing descriptions of twenty new species, was read by Prof. Bell (*post*).

Messrs. H. W. Burrows, C. D. Sherborn, and G. Bailey's paper on "The Foraminifera of the Red Chalk" was also read by Prof. Bell (*ante*, p. 383).

Mr. Karop called attention to the recent investigations by Dr. W. Pfeffer, on what he termed the "chemotaxic" movements of Bacteria, Flagellata, and Volvocineæ, meaning by "chemotaxis" the phenomenon exhibited by these organisms in the presence of certain substances which attracted or dispersed them according to the nature of the stimulant material. A given substance may act upon one organism, but not upon another—e. g dextrin excites *Bacterium termo* to an extraordinary degree, but not *Spirillum*.

Prof. Bell called attention to a paper recently published by Mr. Wray, giving an account of the structure of a feather.

The following Instruments, Objects, &c, were exhibited:—

Mr. Bailey:—Photomicroscope.

Mr. Bolton:—*Mastigocerca elongata* and *M. rattus*.

Mr. Crisp:—Dumaige's Portable Microscope, Objective Adapter, and Camera Lucida.

Mr. H. Mills:—*Heteromeyenia radiospiculata* n.sp.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. William Cash, F.G.S., Henry C. Corke, Thomas W. Johnson, M.D., and William Penman, Assoc. M.I.C.E.

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